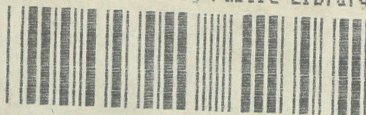




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GEOLOGICAL SURVEY OF OHIO

J. A. BOWNOCKER, State Geologist

FOURTH SERIES, BULLETIN 27
FOR USE IN SCHOOLS

GEOGRAPHY OF OHIO

By RODERICK PEATTIE, Ph. D.,
ASSISTANT PROFESSOR OF GEOLOGY,
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TABLE OF CONTENTS

	Page
Introduction.....	1
CHAPTER I—SURFACE FEATURES AND SOILS	
Relief.....	3
Glacial plains.....	4
Hill country.....	6
Physical history.....	9
Soils.....	11
CHAPTER II—CLIMATE	
Controls of climate.....	15
Temperature.....	16
Precipitation.....	19
Winds.....	21
Data for Columbus.....	22
Weather and crops.....	24
Floods.....	24
Droughts.....	27
Natural vegetation.....	27
CHAPTER III—AGRICULTURE	
Extent of cultivation.....	29
Cereals.....	34
Hay and grass.....	40
Fruits.....	41
Other crops.....	43
Stock raising and dairying.....	45
The role of glaciation.....	50
Farm values.....	53
Early conditions of agriculture.....	55
Rural conditions today.....	56
CHAPTER IV—MINERAL RESOURCES	
Introduction.....	61
Peat.....	63
Coal.....	64
Iron ore.....	69
Oil and gas.....	70
Salt.....	75
Gypsum.....	77
Industrial limestone.....	77
Cement.....	79
Lime.....	80
Building stone.....	80
Abrasives.....	82
Sand and gravel.....	82
Clays and shales.....	83
Mineral waters.....	86

CHAPTER V—TRANSPORTATION AND THE DEVELOPMENT OF INDUSTRIES

	Page
Effect of early isolation upon industry.....	87
River traffic.....	89
Zane's Trace and the National Highway.....	92
The canals.....	97
Iron manufacture and the influence of the lakes.....	102
The railways.....	105
Clay industries.....	107
Recent aspects of transportation.....	108

CHAPTER VI—SETTLEMENT AND DEVELOPMENT

The importance of position.....	111
Conditions of Indian life.....	112
Early settlements and their settlers.....	113
The growth of the State.....	116
The character of the present population.....	119
The industrial growth.....	121
The Cincinnati district.....	125

ILLUSTRATIONS

PLATES

	Facing page
I. A—Hill country, Monroe County	42
B—Valley of Muskingum River, Muskingum County.	
II. A—Mining coal, Belmont County	68
B—Tipple for screening and loading coal, Belmont County.	
III. A—Oil field, Fairfield County	74
B—Tank farm for storing oil, Fairfield County.	
IV. A—Interior view of old salt furnace, Morgan County	82
B—Cutting pulp stone, Columbiana County.	
V. A—Remains of old iron furnace, Jackson County	90
B—Modern iron furnace, Columbus.	
VI. A—Canal boat, Dayton	100
B—Canal at present, Tuscarawas County.	
VII. A—Ohio River at Sciotoville, Scioto County	108
B—Gorge of Licking River, Licking County.	
VIII. A—Shale pit, Licking County	118
B—Brick plant, Tuscarawas County.	

FIGURES

	Page
1. Physiographic provinces	3
2. Contour map of portion of till plain	5
3. Contour map of portion of lake plain	6
4. Contour map of portion of unglaciated plateau	7
5. Contour map of portion of glaciated plateau	9
6. Soil map	11
7. Mean annual temperature	15
8. Annual temperature range	17
9. Mean last killing frost in spring	18
10. Mean first killing frost in autumn	19
11. Length of growing season	20
12. Mean annual precipitation	21
13. Annual march of precipitation at Columbus	22
14. Improvement and value of farm lands	29
15. Acreage devoted to corn in 1919	35
16. Acreage devoted to wheat in 1919	37
17. Acreage devoted to oats in 1919	39
18. Distribution of beef and dairy cattle in 1920	47
19. Distribution of dairy receipts in 1919	49
20. Geological map	63
21. Coal fields, coal towns, and clay towns	66
22. Oil, gas, and salt fields	72
23. Limestone and gypsum	78
24. Zane's Trace, the National Highway, and the canals	94
25. Contour map about Findlay	115
26. Contour map about Marietta	117
27. Distribution of urban centers	120
28. Distribution of rural population in 1800	123

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The author owes acknowledgment to many of his colleagues of the Geological Survey and Ohio State University. The detailed knowledge of the State possessed by Dr. John A. Bownocker, the State Geologist, and the fine criticism of Professor Eugene Van Cleef, a colleague in geography, have been invaluable. Other acknowledgments are made at the ends of the chapters with which various specialists have rendered assistance.

INTRODUCTION

There is little about Ohio that is surprising. On the other hand, there is much that is interesting and a great deal that is unknown or little appreciated. Nearly square in shape, of uniform and moderate climate throughout, having no area without a rich natural endowment, its 40,740 square miles support some 5,759,394 people in harmony and prosperity. With the exception of the southeastern part of the State, communication is of uniform simplicity, but even in that hilly section the mineral resources have supported the construction of railways. The shape of the State, the ease of communication, the reasonably equal distribution of natural resources of one sort or another bring the five million and more people into relations with each other which make for unity and strength. The history is one of prosperity, and the basis for this prosperity is to be found in the geography of Ohio: its situation, shape, surface features, soils, climate, mineral resources, and fuels.

Situated as it is between the industrial East and the agricultural Midwest, it partakes of the character of both and shares in the advantages of both. Youngstown on the extreme eastern border is like a Pennsylvania iron center. The coal as well as the oil and gas of Pennsylvania and West Virginia are shared by Ohio. Dayton on the western border is an example of a farming center, though now much enlarged by manufacturing, a condition characteristic of the farming centers of the mid-west. Whole counties of agricultural Ohio are counterparts of counties in Indiana and Illinois. A second and important element is that the State lies in the path of the traffic between the Superior iron fields and the coals of West Virginia. Of the climatic situation more will be said later.

The situation between Lake Erie and the Ohio River has been and is of great importance. In the days of water transportation all of the traffic from the East passed the immediate borders of the State. Today these same two bodies of water help to force the land traffic of the northern United States to pass through Ohio. The agricultural lands and mineral resources have enabled it to utilize to the fullest extent the advantage of having these lines of communication. It has also meant the founding and the prosperity of many industries not dependent upon natural resources of the State. An example is the rubber industry of Akron.

This book is written for the citizen who would know why his State is great, but more particularly, it is hoped that it will come into the hands of the teachers in the primary, secondary, and normal schools, and so pass on to a greater number. Geographic education should begin with home regions. It is by learning the home geography that we acquire

those principles of geography which permit us to understand foreign lands and peoples. Too often the well known facts of one's environs lose their significance through familiarity. The coals of the southeastern part or the soils of the northwestern part of the State are as important to the livelihood of the peoples of Ohio as are the sea foods to the Eskimo, the camel to the nomad of the desert, or the rice paddies to the Japanese.

CHAPTER I

SURFACE FEATURES AND SOILS

RELIEF

Within the State of Ohio are portions of four of the physiographic provinces of the United States. The central and western portions of the State lie within the (1) Glacial Plains of the Central Lowland, and at the north are the (2) Lake Plains; the eastern part of the State is

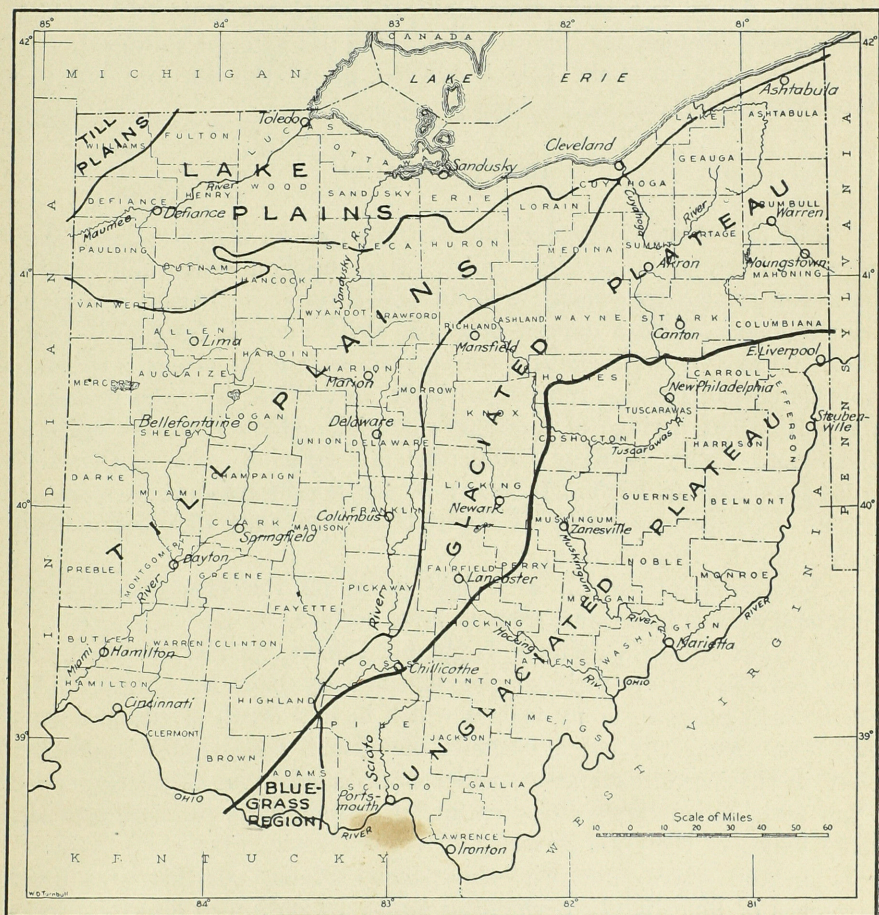


Fig. 1—Physiographic Provinces. The heavier line denotes the glacial boundary. The Lake Plain is remarkably flat as are sections of the Till Plain. Other portions of the Till Plain are undulating and contain morainic ridges. Near the streams it may be severely dissected. The Unglaciaded Plateau is rough and the Glaciaded Plateau, although rough, has been much modified by the ice. (As determined by Professor G. D. Hubbard and produced here through his courtesy.)

within the limits of the Allegheny Plateau, the northern and western portions of which are known as the (3) Glaciated Section and the southeastern as the (4) Unglaciated (Kanawha) Section. There are small parts of other physiographic divisions which extend into Ohio for short distances, but from the point of view of local geography they may be omitted. (Fig. 1, p. 3)

Generally speaking, the State is between 500 and 1,500 feet above sea level. One-fourth is above 1,000 feet and less than one square mile, near Bellefontaine, is about 1,500 feet. Campbell's Hill, east of that city, attains an elevation of 1,550 feet and is the highest place in Ohio. There is a strip from Gallipolis down the Ohio River which falls below 500 feet, the lowest point being the extreme southwest corner of the State. Lake Erie is 573 feet above the sea and 140 feet above the Ohio River at Cincinnati.

GLACIAL PLAINS

The characteristic topography of three-fourths of the State is that of a glaciated plain of slight relief. Here upon a topography which had been eroded by streams well advanced towards old age, the great ice sheet spread out a deposit of glacial drift which is frequently more than 100 feet in thickness and whose surface in most places is remarkably smooth. The ice retired haltingly and where its edge remained for a time left a ridge of morainic material. Good examples exist in the Scioto Valley between Chillicothe and Marion, and to the west from Hamilton to Lima. In many of the northward-flowing streams, waters were ponded as the ice withdrew, and thus temporary lakes were formed. (Fig. 2, p. 5)

The sediments which were laid down on the bottoms of these temporary lakes have an extremely level surface.

Parts of Brown, Clermont, Highland, Clinton, and Warren counties were covered by an early glacier but not by later ice sheets. This earlier drift plain is cut by valleys which have a depth of 100 and even 200 feet. Near the larger streams the glacial topography is rougher than in the interstream areas, which is especially true of southwestern Ohio with its relatively thin coating of drift and its proximity to the deep valley of the Ohio River.

On the whole, however, the Glacial Plains of Ohio are broad stretches of but slightly undulating lands, which afford easy transportation and whose soils form the State's most valuable asset.

The Lake Plains are merely a strip from Conneaut to Cleveland, but from Cleveland to Sandusky they widen from 5 to 20 miles. Extending southwestward from Toledo along the Maumee Valley there is the flat bottom of a bay of the once more extensive Lake Erie which stretches over most of Ottawa, Lucas, Fulton, Henry, Defiance, Pauld-

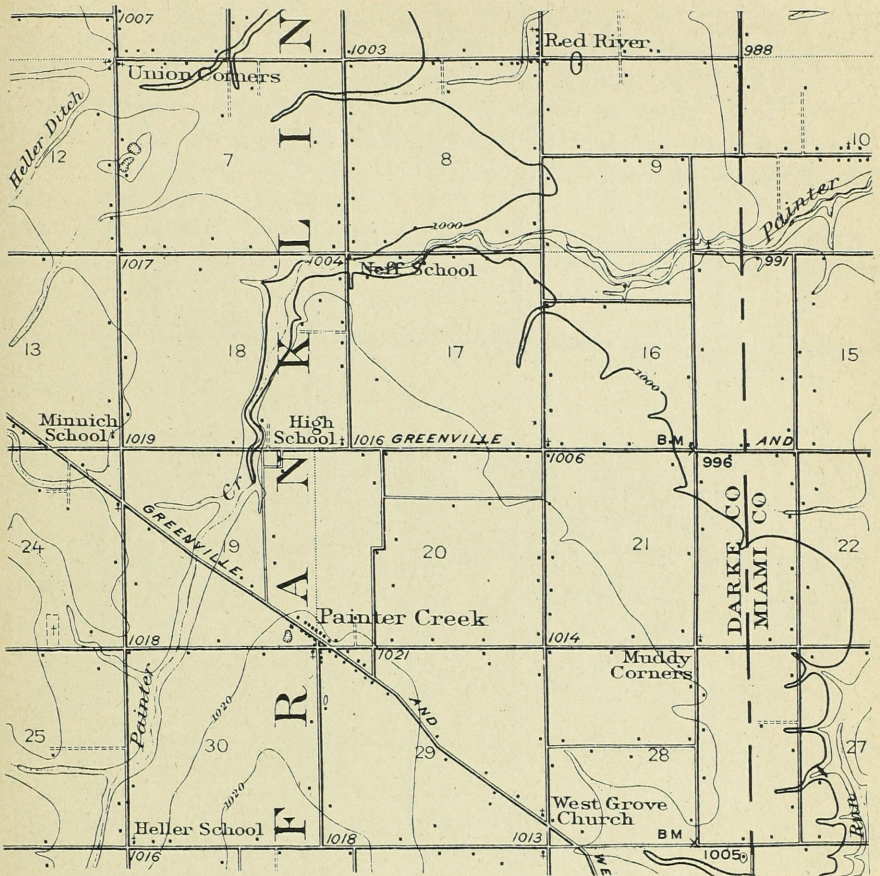


Fig. 2—The Till Plain. A characteristic example of the remarkable levelness of the Ohio till plain. The turnpike cuts diagonally across the plain while the other roads are laid out along section lines. The number of houses to the square mile and the metaled roads (indicated by the heavy line) bespeak the fertility of the soil. (U. S. G. S. map. Covington quadrangle. Darke County. Scale about a mile to the inch. Contour interval 20 feet.)

ing, Van Wert, Putnam, Wood, Sandusky, and Erie counties, with that remarkable levelness characteristic of lake bottoms. The land is so level that much of the area had to be drained before it could be farmed. This includes what is known historically as the "black swamp" region. Artificial drainage was also necessary in the smaller lake bottoms included within the Glacial Plains. (Fig. 3, p. 6)

Few of the valleys of the Glacial Plains have reached maturity of development. The river valleys beyond the glacial limit are farther advanced but even the Ohio River has narrow flood plains. However, the Scioto, Miami, Hocking, and Tuscarawas rivers all have important bottom lands developed for the most part in preglacial times. Derangement of river courses has left many good sized valleys today without

streams of importance, and these are found in the unglaciated as well as in the glaciated portions of the State. Such is the valley from near Waverly to Wheelersburg, which contains Beaver Creek and Little Scioto River. Another valley of this type is the one which extends from Lancaster eastward to Bremen, and still another is the valley from Newark eastward to Trinway.

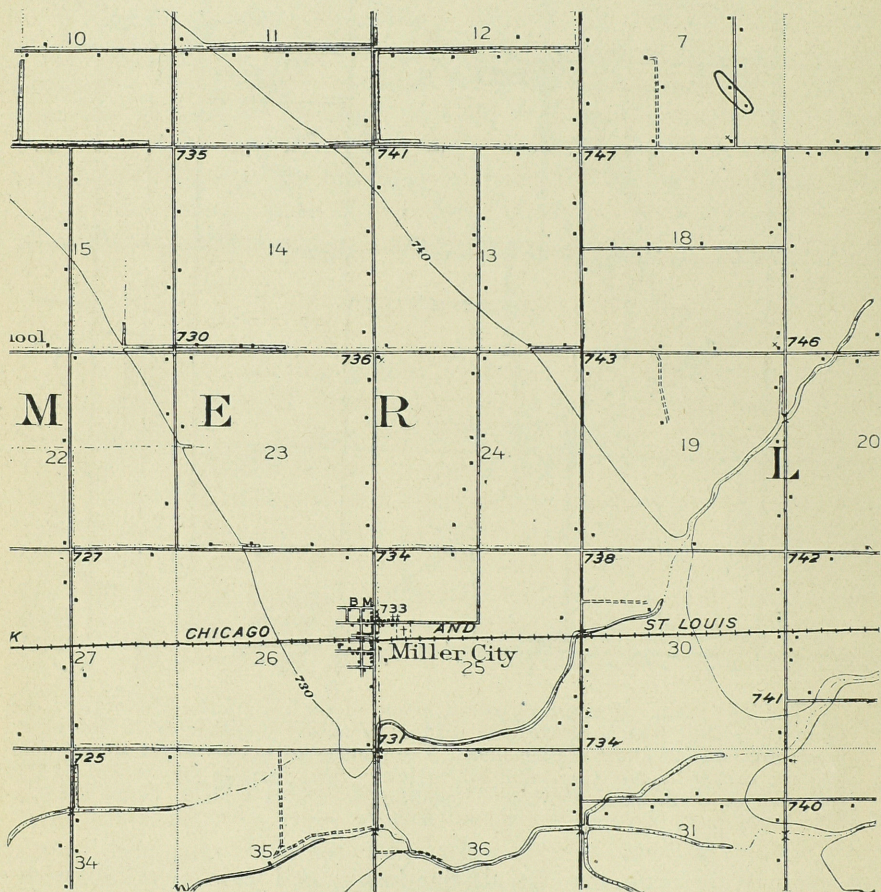


Fig. 3—The Lake Plain. The parallel contour lines represent the direction of the ancient shore lines. Note the drainage ditches beside the roads. The land is so rich and the population so dense that 45 per cent of the land of this county is in farms of 50 to 99 acres each. (U. S. G. S. map. Ottawa quadrangle. Putnam County. Scale about 1 mile to the inch. Contour interval 20 feet.)

HILL COUNTRY

The most hilly part of Ohio is the Unglaciated or Kanawha Section of the Allegheny Plateau which constitutes the southeastern quarter of the State. Here a plateau of moderate elevation has been maturely dissected by streams until it consists of narrow ridges and

steep-sided valleys with depths as great as 300 feet, most of which have very narrow flood plains. The plateau has not been entirely destroyed and on it is much of the farming. The valleys are sufficiently well developed, however, to hold the railways and hence many of the towns, such as Coshocton, Zanesville, Chillicothe, Logan, and Youngstown, are near the level of the rivers. The ridges are narrow in the region of the main streams and even back in the region of tributaries the hill roads have heavy grades. The valleys themselves are in places wild, densely wooded, and expose bedrock in great cliffs, which may contain coal. In places where sandstone and conglomerate rocks cap the hills and so protect them, the valleys are very deep and have steep slopes; hence the rough character of parts of Scioto, Lawrence, Pike, Hocking, and Ross counties. (Fig. 4, below)

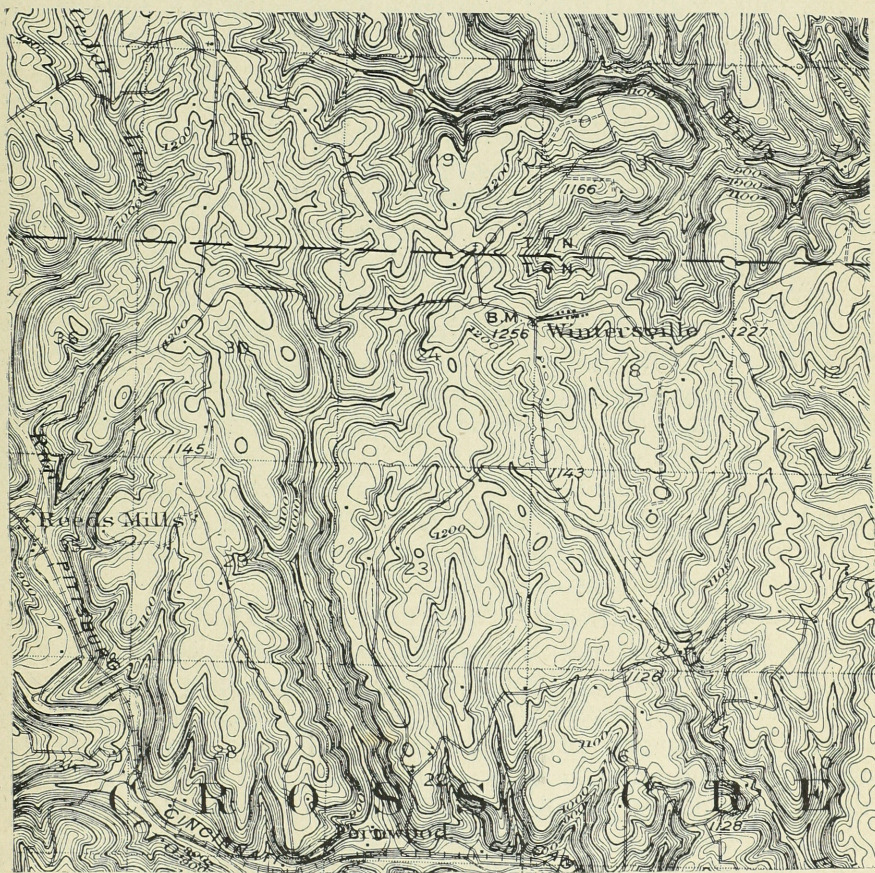


Fig. 4—The Unglaci-ated Plateau. Note that the flat-topped hills, representing an old erosion surface, hold the farm houses, but that the railway, with a tunnel, is in the valley. (U. S. G. S. map. Steubenville quadrangle. Jefferson County. Scale about 1 mile to the inch. Contour interval 20 feet.)

The northern section of the hill country is glaciated. Here valleys are less deep due to glacial erosion of the hills and glacial deposition in the valleys. The erosion has rounded and mellowed the outlines of the hills. Though the country is quite rough the drainage is less perfect than in the unglaciated portion of the plateau. One region of conglomerate about Doylestown, Akron, and Chardon, has somewhat greater relief than the rest. But, generally speaking, the glaciated portion of the plateau is more favorable to agriculture, its scenery is more varied, and it lacks the steep-sided valleys of the unglaciated section. (Fig. 5, p. 9)

River valleys, some of them both wide and deep, form an interesting feature of the physiography of Ohio. First in importance is the valley of the Ohio River, though only one side belongs to this State. This valley varies in width from place to place but it is nowhere wide in proportion to the size of the river. For example, on the Ohio side in the vicinity of Martins Ferry it is in places merely wide enough for the railroad bed; in Scioto County near Haverhill it is one and three-fourths miles wide. In Adams County within 3 miles it varies from one-sixteenth to one and one-third miles in width. The 300 foot cliffs that rise almost directly from the water near Aberdeen, Brown County, are flanked by extensive flats a mile in width. Its depth is as much as 500 feet below adjacent uplands in Ohio, and as it receives the drainage of much the larger part of the State, it has played a prominent part in the development of the topography. (Pl. VII A, p. 108)

In the northern part of the State are such valleys as the Maumee, Sandusky, Cuyahoga, and Grand. Most of these are wide and in the main rather shallow. That of the Cuyahoga, however, is relatively narrow and near Cuyahoga Falls it forms a picturesque gorge. As the divide between the north-flowing and south-flowing rivers is considerably north of the center of the State, these rivers have about half the length of the tributaries of the Ohio.

South of the watershed between Lake Erie and Ohio River are such valleys as the Tuscarawas, Walhonding, Muskingum, Little Muskingum, Hocking, Scioto, Little Miami, and Miami. All of these valleys, except the last two, lie almost wholly within the Allegheny Plateau. In places they measure a mile in width as shown in the Tuscarawas, Scioto, and Miami valleys. The valley of the Scioto near Waverly attains a maximum width of $3\frac{1}{2}$ miles and that of the Miami below Hamilton $2\frac{1}{4}$ miles. Such great widths, however, are unusual. In many places the valley bottoms are from 200 to 300 feet below the adjacent uplands.

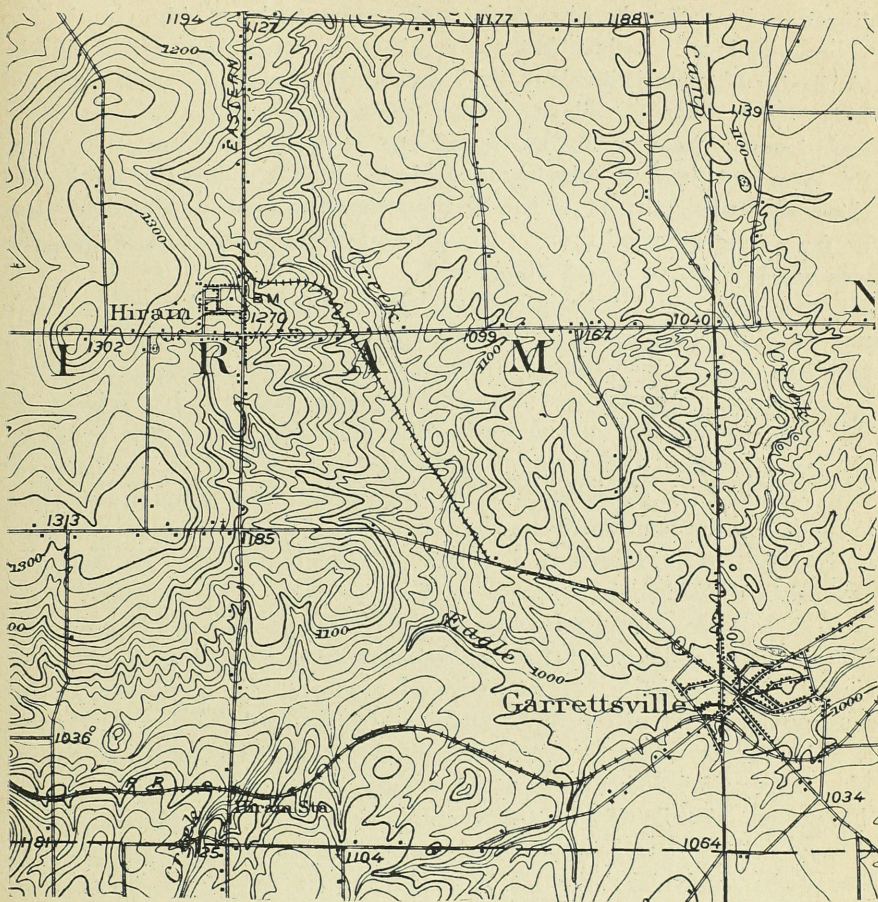


Fig. 5—The Glaciated Plateau. Bed rock here controls the major features of the topography. An interurban railway is shown connecting Hiram and points beyond with the steam railway. (U. S. G. S. map. Garretttsville quadrangle. Portage County. Scale about a mile to the inch. Contour interval 20 feet.)

PHYSICAL HISTORY

To appreciate the physiography of Ohio, the soils, and the mineral resources, one should first know the essential features of the physical history, that is, its geologic background.

The bedrocks of Ohio are sedimentary and were laid down in the seas of geologic antiquity. Limestone is the characteristic rock of the western part of Ohio, and shale and sandstone of the eastern part. These lie upon each other and as a rule are gently tilted to the south-east. Thus in making a cross section from west to east one would come upon younger and younger rocks. The oldest rocks of the State are those in the Ohio Valley a few miles above Cincinnati.

The surface of the plateau portion of the southeast has been worn down by stream erosion to a plain known as a base level and then up-

lifted to be maturely dissected to the present sharp ridges and deep narrow valleys. Today that old erosion surface is represented by the similarity of summit levels of the ridges and the more or less flat-topped hills. The present valleys of the unglaciated portion of the State were begun, of course, before the advent of the ice, and are still youthful in aspect, having only begun their work of leveling the land. To the west and northwest of the plateau country, river erosion had gone on for a longer period than in the plateau region, and most of the area was worn down to broad plains.

Over this country the great ice sheets advanced and spread a thick mantle of glacial drift. The ice even crept up onto the plateau at its northern and western edges. However, the ice was greatly retarded in its southward progress because of the greater relief and roughness of this region than that of the west. The hills which took the brunt of the ice movement were rounded and smoothed and the valleys between were choked with glacial drift. The relief, therefore, is much less than in the Kanawha Section of the plateau, and in places it is even monotonously level, as in Hartford Township of Licking County or Andover Township of Ashtabula County.

There were several advances of the glacier in Ohio. The first, the Illinoian, was so long ago that the topography of its plains now has few glacial characteristics. These ancient deposits are exposed in the southwestern part of the State and in a few other localities, where the *later* ice sheets were not extensive enough to cover the earlier deposits. The Wisconsin ice sheets, of which there were two, are responsible for the present details of the topography of most of the glacial plains. Former valleys were covered with as much as hundreds of feet of drift. Today the preglacial valleys have little or no surface expression and are mainly known through well borings. A good example exists in Auglaize and Mercer counties.

About the margin of the ice sheet many temporary lakes formed, the most important being in the northern part of the State. When the present outlet of Lake Erie was closed by the ice the waters rose until they flowed over the divide to the south, which happened to be lowest in northeast Indiana where the headwaters of the Maumee and Wabash rivers meet. There were four stages to the flooding of the land and they are known as the Maumee, Whittlesey, Warren, and Lundy. Silts and sands deposited in the bottom of these lakes were laid down with remarkable evenness and the topography, therefore, is now exceedingly flat. The waters of the retreating lakes have left for us all the usual phenomena such as beaches, sand spits, ancient lagoons, etc. The long parallel sand beaches today form the elevated well-drained sites of highways and it is along these "ridge roads" that the oldest establishments of the community are found, as they were seized upon by the early settlers as favorable locations for pikes and highways.

There are throughout the State, but more notably south of the glacial margin, great preglacial valleys, which may now contain but insignificant streams, leaving broad acres for farm land. During the presence of the ice the streams were forced out of their valleys, and after the partial or complete retreat of the glacier, the streams were not able to recover entirely their former courses; hence there are large valleys which hold no stream other than that which is carrying away the immediate waters.

SOILS

In soils there is a great deal concerning agriculture, history, social and economic relations. They are Ohio's greatest asset. There are a great many factors back of agricultural prosperity, not all of which are geographic, but fundamentally it is the soils which are of prime importance.

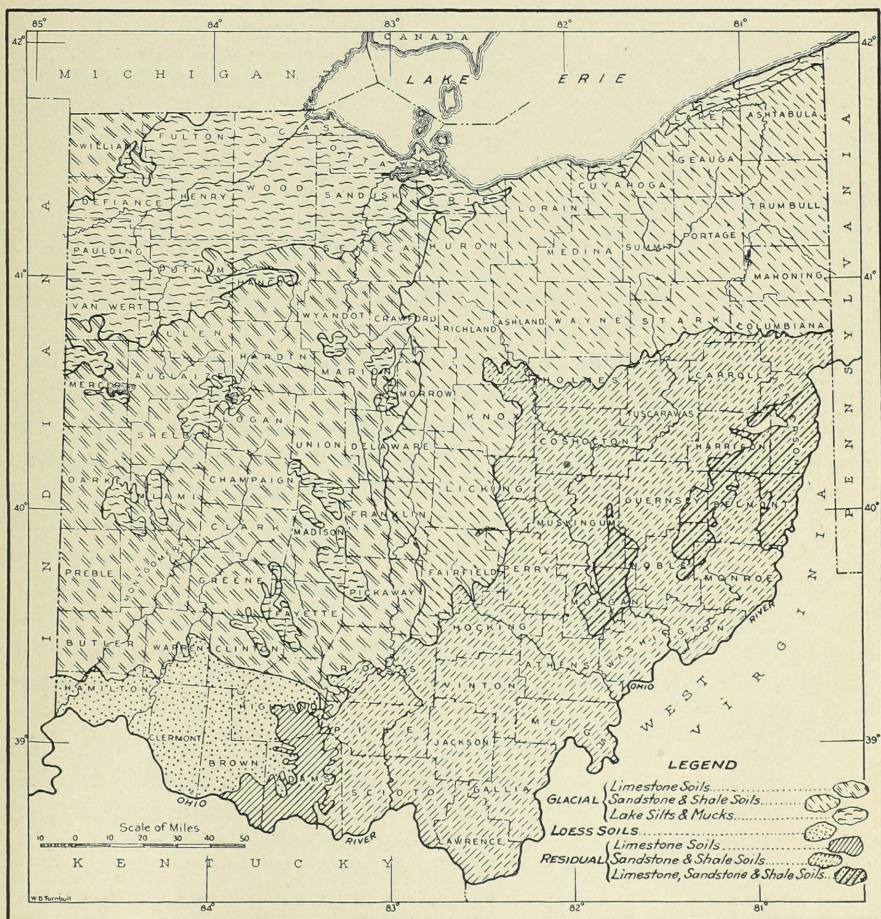
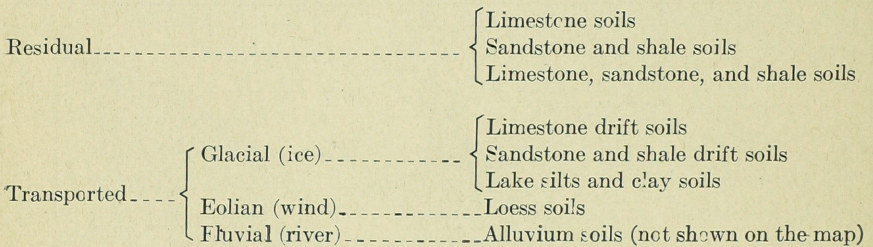


Fig. 6—Soil Map. This has been adapted from the detailed map of Coffey and Rice. "A Reconnaissance Soil Survey of Ohio." (U. S. Dept. of Agr., Bur. of Soils.)

Soils are mantle rock which has been formed from solid or bed-rock by physical and chemical agents. Soils may be found in place from the disintegration of the rock of the immediate country, or they may be formed elsewhere and transported to their present site. Residual soils, those formed in place, are, in Ohio, of three types: (1) limestone soils, (2) sandstone and shale soils, and (3) a combination of the two classes. There are four agencies which have been instrumental in transporting soils from one part of the State to the other or to the State from outside. These are, in order of importance, the great ice sheet that once spread over the region, the rivers of the past and present, lakes of the past with their currents and waves, and lastly, but nevertheless quite important, the wind. (Fig. 6, p. 11)

General Classification of the Soils of Ohio



The glacier came from the north and therefore not a little of the glacial drift was brought down from Canada, as through the drift are crystalline rocks, granites, and the like, which are Canadian "erratics." But mostly the drift is made up of materials which the glacier gathered from the region immediately to the north of where the deposit now lies; hence the soils will be of a limestone base or a shale base accordingly as the rocks to the north are of limestone or shale.

The rivers which flowed from the melting ice were laden with this glacial detritus and they sorted the materials, depositing the sand and gravel near the ice and carrying the finer materials farther down stream. These valley deposits form important soils. They have since been cut into by the streams and are today represented in terraces; but they should not be confused with the recent alluvium which is more or less at stream level.

The bottoms of the temporary ice-dam lakes formed during the retreat of the ice are of finely sorted silts and clays, which, once drained, form marvellous farm lands. The glacial lakes which preceded Lake Erie have left, where once they were, a variety of soils which range from sand to fine clay land. The single example of true sandy soil in all of Ohio is along an ancient beach (of glacial Lake Erie) which runs through Sandusky, Lucas, Fulton, and Henry counties.

Today the rivers are slowly but surely reducing the land to the

level of their flood plains and carrying away much of the best soils in their muddy waters. The soil of the flood plains is but material in transit to the sea waiting to be rehandled in its downward journey. These rich bottom lands constitute the best corn land in the State. The valleys of the Scioto River south of Chillicothe and of the Miami south of Dayton are good examples.

As most of the limestone areas of the State have been glaciated, few areas of residual limestone soils remain. The largest area is in and about Adams County; much smaller tracts exist in Belmont, Monroe, Noble, and Morgan counties. Farmers owning such lands boast of their superiority to sandstone and shale soils.

Most of the unglaciated area of the State is underlain by sandstones and shales. The soil is found in varying thickness and in various textures and chemical compositions. For example, in parts of Scioto, Pike, and Lawrence counties weathering has yielded only a sandy loam; a shale of Perry, Lawrence, and other counties gives a red soil which is not constant in character; but the soils are decidedly wanting in lime. The blending influence of the glacier is much missed and there are as many soils as there are combinations of bedrock, slope, and stream conditions. Along the Ohio, Muskingum, Hocking, and other rivers of eastern and southern Ohio, the valley walls are so steep that difficulty in tilling, or danger of soil wash once tilling is begun, is so great as to restrict notably the area under cultivation. The residual soils on the uplands support hay and grain crops and those on the slopes are used for pastures and orchards.

The great farming wealth of the State, however, is derived from the glacial soils as the chemical and physical mixing of these soils give them great fertility. Certainly the glacial soils have a more uniform fertility and a more even topography than the non-glaciated. This is a matter which involves many factors and will be treated more fully in the chapter on Agriculture.

Bibliography on Relief and Soils

"The Physical Geography of Ohio" by J. S. Newberry (Geol. Surv. of Ohio, Vol. I, Pt. I, 1873) still stands as one of the best descriptions of the relief of the State. "A Reconnaissance Soil Survey of Ohio" by G. M. Coffey and T. D. Rice (U. S. Dept. of Agr., Bur. of Soils, 1915) is an excellent discussion of Ohio soils. The same bureau has several studies of small regions. A readable account of the "Geologic Development of Ohio" is the brief article by Frank Carney (Scientific Laboratories of Denison Univ., Bull. 16, 1910-1911, pp. 365-380.)

The physiographic divisions herein adopted are after G. D. Hubbard who has a "Physiography of Ohio" in preparation. There are a large number of detailed studies of physical history of Ohio among which are two specially worthy of note: Frank Leverett's "Glacial Formations and Drainage Features of Erie and Ohio Basins" (U. S. Geol. Surv. Monograph 41, 1902) and W. G. Tight's "Drainage Modifications in Southeastern Ohio" (U. S. Geol. Surv. Prof. Paper 13, 1903). Noteworthy are three

recent bulletins of the Geological Survey of Ohio: the "Columbus Quadrangle" (Bull. 14); the "Cincinnati Quadrangle" (Bull. 19); and the "Camp Sherman Quadrangle" (Bull. 23). Ohio has been completely mapped by the topographic section of the United States Geological Survey.

The hydrography has been extensively written upon. The general reader should see Flynn and Flynn on "Sandusky, Maumee, Muskingum, and Miami Drainage Areas in Ohio" (U. S. Geol. Surv. Water Supply Paper 91, 1904) and Fuller and Clapp on "The Underground Waters of Southwestern Ohio" (U. S. Geol. Surv. Water Supply Paper 259, 1912), which last has a large bibliography.

The base map of Ohio used throughout this bulletin is from the Sherman-Turnbull map (1918) which is the most accurate of the maps of Ohio.

CHAPTER II

CLIMATE

CONTROLS OF CLIMATE

As Ohio is physiographically a transition between the plateau regions of the east and the mid-continental plains, so also it is climatically a transition from the east coast climate to that of the continental interior—from that of New Jersey to that of Illinois.

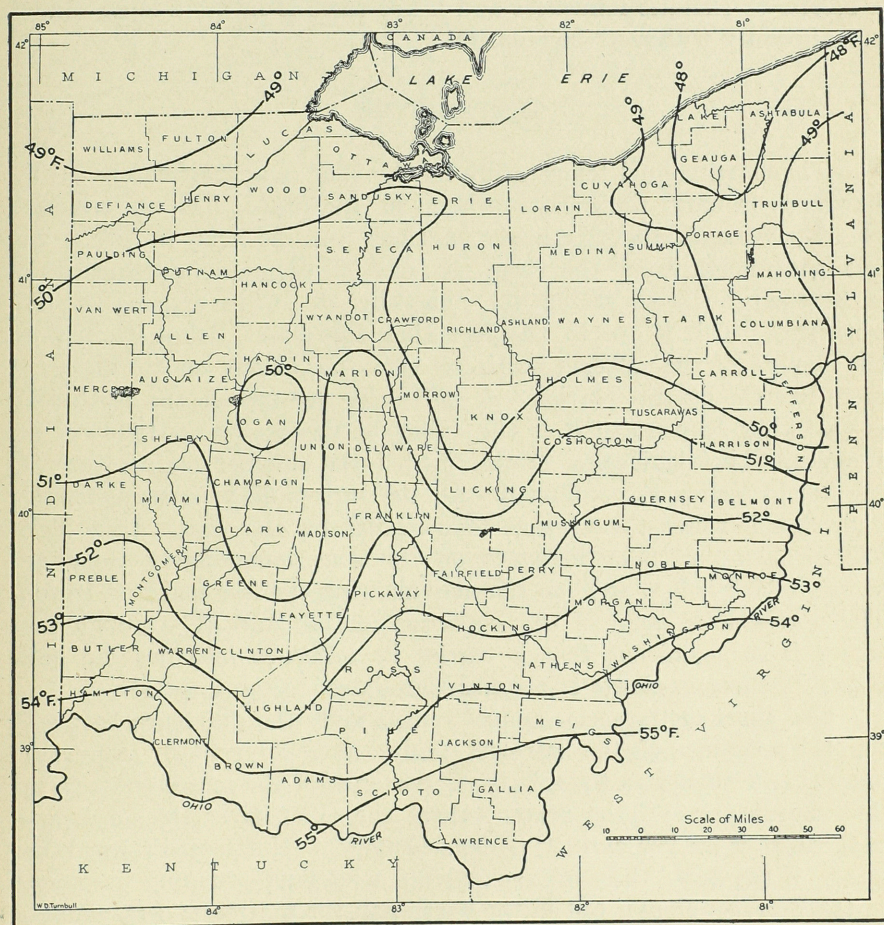


Fig. 7—Mean Annual Temperature. Twenty-five year record for all stations. The lines represent equal mean annual temperatures. This, as with all other climatological charts in this bulletin, are the latest for Ohio and are reproduced through the courtesy of W. H. Alexander of the Weather Bureau Station at Columbus.

The major control of the climate is latitude. This shows in the difference in temperature between the north and the south of the State, a matter of prime importance. A second and equally important control is the prevailing southwesterly wind. Cyclonic storms have a great influence on the variability of the climate and are a dominant note in the weather, particularly winter weather. The Great Lakes, especially Lake Erie, not only affect the temperature of the northern part of the State but also they influence the amount of rainfall and the severity of the storms. Just as the lakes are an influence so also the plains to the windward are important. Lastly, the topography of Ohio itself is significant. No part of the State has sufficient relief to act as a barrier to climatic influences and hence there is rather a large degree of uniformity within its boundaries.

TEMPERATURE

The mean annual temperature for the year is approximately 51° F. Lawrence County, the most southern in the State, has an average of 55°, whereas the northeast sections run as low as 48°. As one goes north from the river, the rate of decrease of temperature is lessened as is shown on the chart by the wider spacing of the isotherms. This is due to the fact that the Great Lakes ameliorate the climate of the extreme north to such an extent as to make it more like the central portion. A noticeable feature of the isotherms is that they loop north over the valley of the Scioto, particularly in summer. The significance of this is that the summer temperature of the Scioto Valley as contrasted with the surroundings is so distinctly high that it raises the average temperature for the year. Lake Erie has its own particular influence on the zone immediately along its shores, which is best seen on the map showing the last and first frosts. The north-south trend of the isotherms for 50° and 51° through the center is so significant that it carries its influence into farming and shows its effect in charts of the planting dates. (Fig. 7, p. 15)

The chart of the mean annual ranges gives the difference between the temperatures of the warmest (July) and the coldest (January) months and illustrates the relative importance of the major controls in the various parts of the State. Along the Ohio River the mean annual range is as low as 40.3° (Adams County). Northward toward the center of the State the contrast between winter and summer becomes, on the average, greater but in the north half the matter is less simple. In the northwest part of the State the range between the two extremes is almost 50°, but to the east the effect of the lake shows its moderating influence and at the northeast corner there is a range of less than 44°. Herein are written most significant matters of agriculture. Consider, for example, the distribution of the grape plant. (Fig. 8, p. 17)

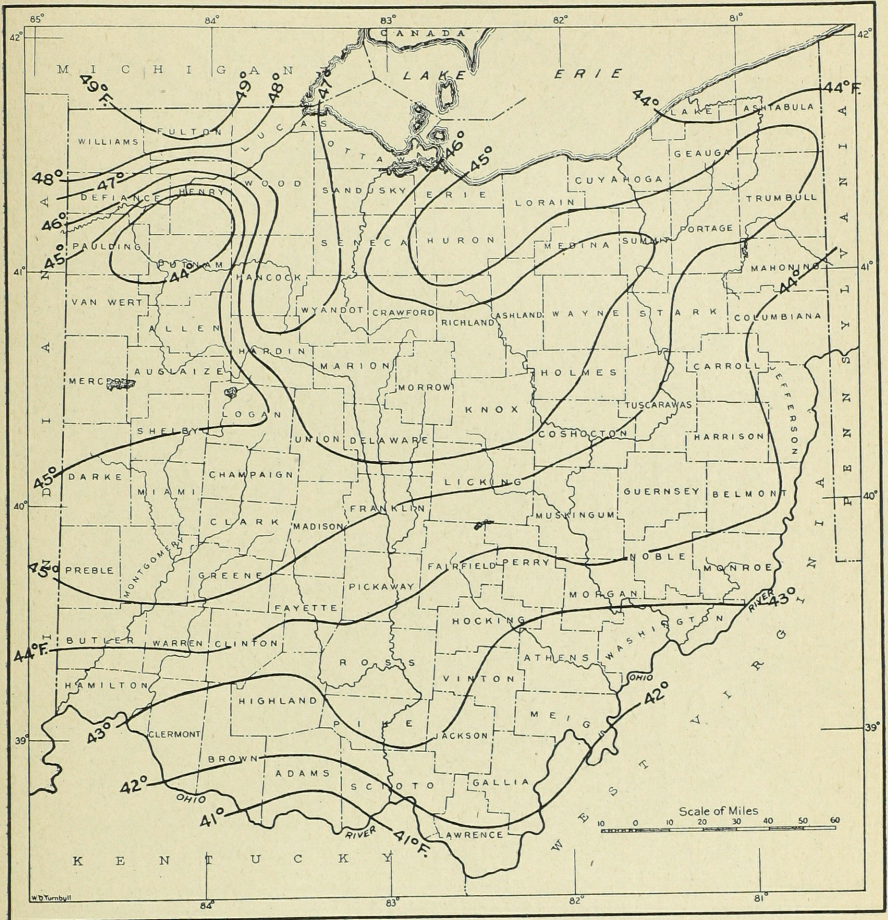


Fig. 8—Mean Annual Ranges of Temperature. Showing the difference between the average temperatures of the warmest and coldest months. Twenty-five year record for all stations. (After Alexander.)

The geography of the last and the first killing frosts shows how extreme is the effect of the lake. The lines of equal dates hug the lake shore and come in such quick succession as to make it difficult to get them on the map. In short, the effect of the lake in controlling frosts is decided but this effect is restricted to farms only a few miles from the water's edge. The hill country, as in Vinton County, has early frosts, which is characteristic, for the little valleys allow the collection of cool air which in the evening slides down from the hilltops. So it is that the first frost occurs on the valley farm and not on the upland farm, as is shown by the map. It is always the trees in the hollows that are first colored by the frosts in fall. (Figs. 9 and 10, pp. 18-19)

The length of the growing season is computed merely by taking the number of days between the average last and the average first kill-

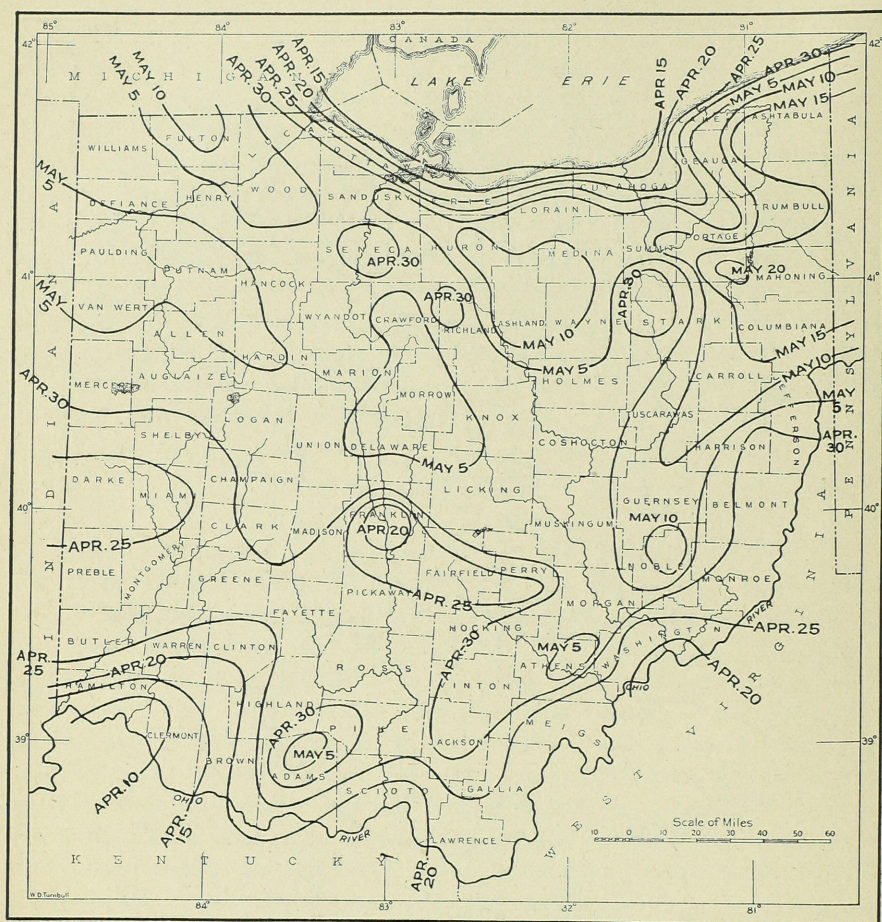


Fig. 9—Dates of Average Last Killing Frosts in Spring. Based on ten to twenty-five year record. (After Alexander.)

ing frosts. All parts of Ohio are provided with an ample growing season for most crops, but, nevertheless, the distribution of the frost free period is one of critical conditions, and the map shows possibilities and limitations for special plants. It is evident on all the maps that Cincinnati, Columbus, and Cleveland are regions of special conditions. There are to be found the best equipped stations for weather observation and one may suspect that they stand out as having special conditions because of the excellent records. The Ohio Valley has a growing season of more than 178 days and the northern part of the State has one of 150 days, excepting the strip along the lake. Again the influence of the water is plainly shown for the season there is 192 days, which is longer than that of any portion of the State with the exception of the immediate vicinity of Cincinnati. (Fig. 11, p. 20)

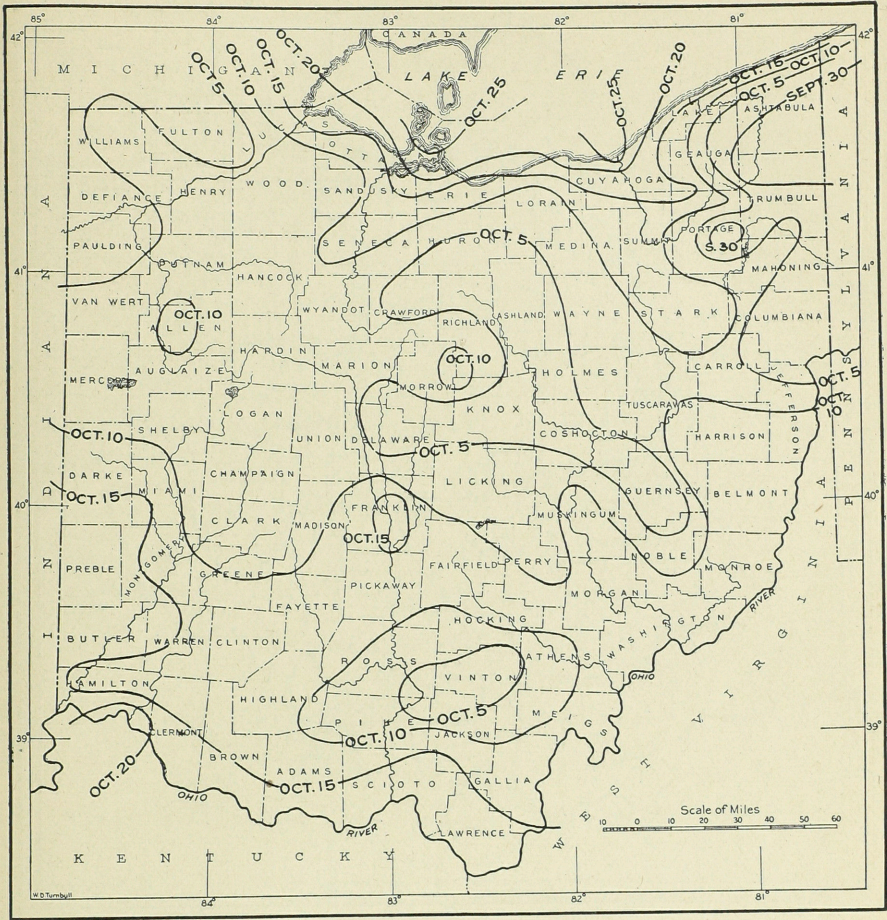


Fig. 10—Dates of Average First Killing Frosts in Autumn. Based on ten to twenty-five year record. (After Alexander.)

PRECIPITATION

Of rainfall there is normally a sufficiency. The mean totals for the year vary from 31 to 42 inches. The annual march of rainfall as shown on the graph is one fortunate for crops, as the spring and summer months have relatively heavy rainfall whereas October has a minimum. As contrasted with Michigan or other continental interior regions, there is considerable precipitation in winter. Normally the rain of an interior region in the belt of westerly winds has a greater contrast between winter minimum and summer maximum than has Ohio. In the United States this is due to the moisture brought from the Gulf region by cyclonic storms and by a general indraft of air to the warm lands in summer and precipitated by cyclonic storms and the usual summer thundershower. Ohio, however, has such frequent occurrence of winter

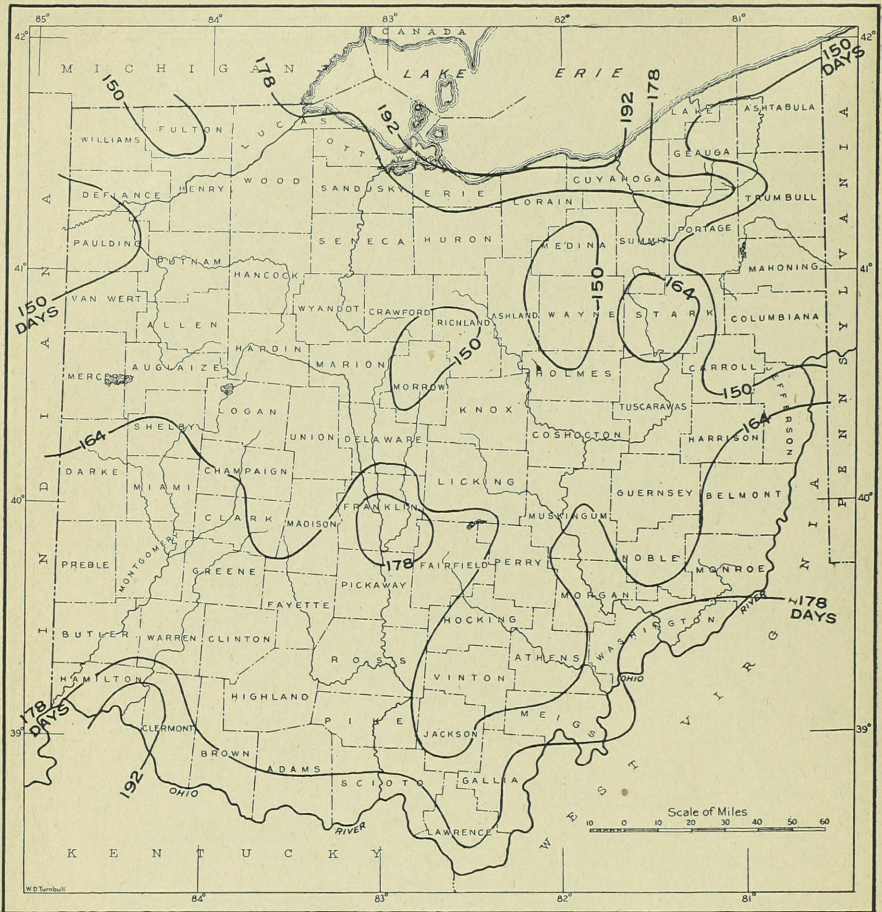


Fig. 11—Length of Growing Season. Length in days between the average last and average first killing frosts. (After Alexander.)

cyclones as to have more winter rain than has Illinois, for example. (Fig. 12, p. 21)

The rainfall of the Ohio Valley differs from that of the lake region, not only in quantity, but in evenness of distribution as well. Along the Ohio where the rain amounts to 42 inches in a year the total number of rainy days is 100; whereas in the north where but 33 inches falls there are 140 rainy days. The rain storm of the Ohio Valley is, therefore, more violent in character and the rain, from the point of view of time, is less evenly distributed. This means greater damage to crops, more run-off, and less ground water, other things being equal. The winter precipitations are especially contrasted. For the Ohio Valley the winter precipitation is in the form of heavy rains; in the lake region it more often takes the form of light snows. The shore of Lake Erie

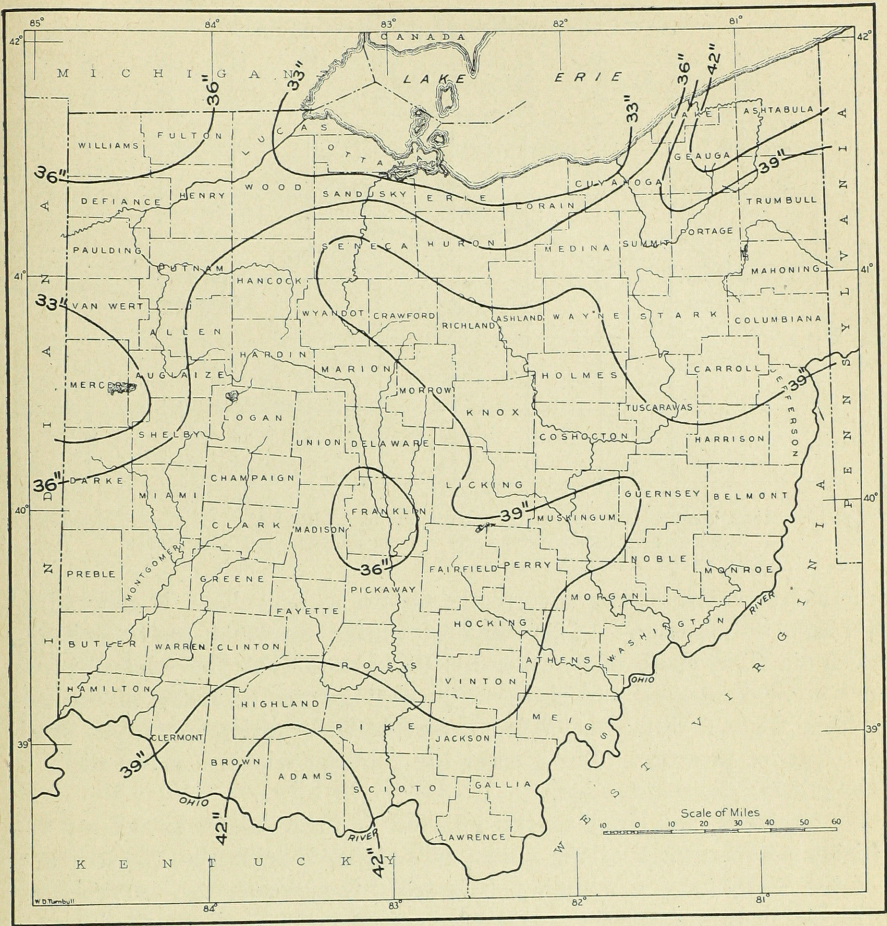


Fig. 12—Mean Annual Precipitation in Inches. Twenty-five year record for all stations, 1895-1919. (After Alexander.)

in the United States has a great deal more snow than the Ohio Valley for two reasons. First, because it is farther north and, second, because the winds which occasionally sweep from the warm lake to the colder land in winter cause snowfalls. The annual snowfall increases from 20 to 60 inches as one goes northward from the river. The average snowfall for Columbus in the center of the State is 25.1 inches and the heaviest in a single year was 67.8 inches. (Fig. 13, p. 22)

WINDS

The winds of Ohio are prevailing southwest, but they are constantly shifting as the cyclonic storms pass through or by the State. A cyclonic storm is merely an area of low barometric pressure into which the winds are blowing in a spiral, counter-clockwise direction. The

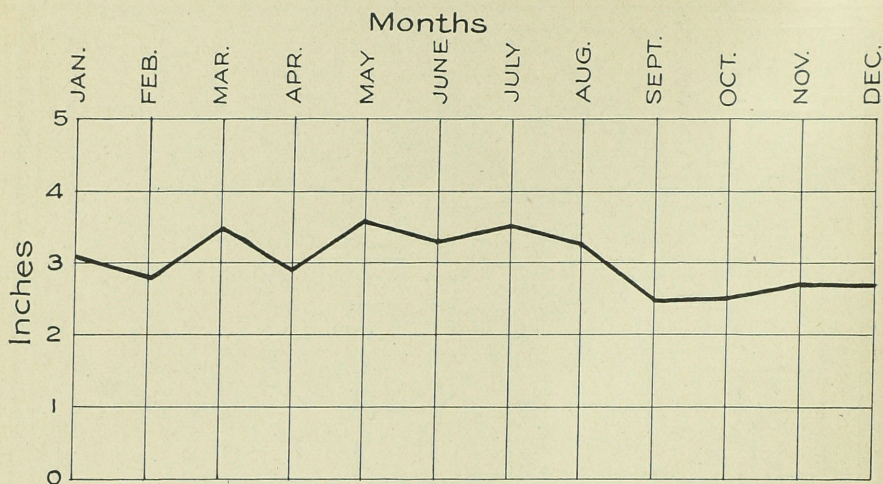


Fig. 13—Mean Annual March of Precipitation at Columbus. This city is centrally located, and hence represents a fair average for the State.

more destructive storm, incorrectly known as a cyclone, is generally a tornado or "twister." The winds of winter are much more decidedly cyclonic than those of summer for the reason that the winter storms are more condensed and therefore present greater contrasts of pressure within a given distance. Wind is merely the shifting of masses of air to equalize pressure. The greater the contrast within a given distance the greater the wind velocity.

Cyclones are significantly affected by the lake. In winter the higher temperatures of the water, as compared with the temperatures of the land, have a tendency to attract the storms and to repel the "highs" or fair weather centers. Hence, the winters along the lake are unusually stormy. In summer the opposite is true and fair weather prevails on the water; and in springtime there seems to be a tendency for high pressures to develop over the lake making protracted fair weather periods along the shore, which are of advantage to the fruit grower.

DATA FOR COLUMBUS

Because of the compact form of the State (it is 225 miles in one direction and 205 in the other) and because of its lack of physical barriers, Columbus may be taken as a representative station. The data for Columbus are given below:

Climatological Data for Columbus: 1879--1919

	Mean annual temperature	Mean annual rainfall
January.....	29.0 degrees	3.12 inches
February.....	29.9	2.82
March.....	39.6	3.44
April.....	51.0	2.90
May.....	62.2	3.62
June.....	70.8	3.33
July.....	75.0	3.59
August.....	72.8	3.27
September.....	66.5	2.48
October.....	55.0	2.52
November.....	41.9	2.69
December.....	32.2	2.66
	52.2 (average)	36.44 (total)

Highest monthly average temperature (July).....79.9 degrees
 Lowest monthly average temperature (Jan.).....15.8 degrees
 Greatest monthly average precipitation (May).....9.59 inches
 Least monthly average precipitation (Nov.).....0.18 inches

Warmest yearly temperature (1881).....54.2 degrees
 Coolest yearly temperature (1917).....49.0 degrees
 Greatest annual precipitation (1882).....51.30 inches
 Least annual precipitation (1902).....26.53 inches
 Absolute extremes of temperature from (1901) 104 degrees to (1884 and 1889) —20 degrees.

Maximum wind velocity (January, 1907) 66 miles.

Average snow 25.1 inches; heaviest snow in any year 67.8 inches.

It must be remembered that the climate represented by any single station is the climate of the section of the State plus the special topographic conditions of the station's situation. This should be taken into account when interpreting the record for Columbus as an average condition for the State in whose center it is situated. For example, Cleveland, Sandusky, and Toledo are on the lake and subject to its influences. Wauseon and Ottawa are in the level prairie black swamp country. Hiram and Bangorville are two of the highest stations in the State. Columbus and Dayton are warmer than the surrounding country because of their situation in valleys which face southward. New Alexandria is on the top of the bluffs in the east. The high level plains of the west are represented by North Lewisburg and Clarksville. Mari-

etta, Portsmouth, and Cincinnati represent the climate of the Ohio Valley.

WEATHER AND CROPS

Cold waves, hot spells, and stormy periods of some duration are cyclonic phenomena. There is an infinite variety of weathers which may be obtained from storms approaching Ohio from different angles or passing the State on different borders. The speed with which a storm is travelling is also of significance. Storms are often "hung up," that is, remain stationary for a long time, and a prolonged hot spell or cold wave may result. Some storms are much more intense than others and changes of weather are accordingly sudden. Stormy areas of lower pressure may come in quick succession or may coalesce to provide longer periods of bad weather conditions. The monthly temperatures or precipitations may vary from the normal and these are very critical matters in agricultural meteorology. Let there be an increase or decrease in any of the meteorological elements beyond the critical point and crops are seriously affected. This is particularly true of the rainfall. To quote directly from J. Warren Smith, "The rainfall is undoubtedly the most important factor to most of the crops in this State, because with the proper amount of water in the soil at the critical period of development the plant will produce a large crop, for the reason that the temperature and the sunshine seldom vary beyond safe limits."

This condition is particularly true for corn and hay. The rainfall of July is especially important to corn whereas in May temperature has the greater significance. This is peculiarly an Ohio condition for in Indiana to the west the July *temperature* assumes a greater importance. For the potato crop the temperatures of June and July are particularly important. Tobacco is influenced more by the temperature of July than any other weather condition. The quantity and quality of the sugar beet depends to a large extent upon the temperature and length of daylight hours irrespective of actual sunshine. All "winter" crops, as wheat, barley, and oats are affected by the weather of that season. Heavy snow in January is important as a cover; in February an excess is negative in its effect; but a heavy covering in March is detrimental. The variations of frost dates are, of course, tremendously important, especially to the vine culture of the north and northeast.

FLOODS

Ohio, and more particularly the Ohio Valley, is unfortunately subject to severe and destructive floods. Since the year 1873 the Ohio Valley has annually been inundated along some part of its course. As many of the important tributaries are within the State, flood conditions prevail also in those valleys. The Ohio Valley itself is particularly subject to significant floods in that it is narrow with a fertile flood

plain which at once attracts settlement and yet almost annually is submerged. The floods of February, 1884, and March-April, 1913, were particularly high.

Floods in Ohio are caused by:

1. Rain which is excessive for several days. When it is drained into streams already swollen it is particularly destructive. This was the cause of the great flood of 1913.

2. Rapid melting of accumulated snow. Ohio is climatically a transition from the rainy winter of the south to the snowy winter of the north. Hence, it is possible, especially in spring, for warm rain to fall upon relatively heavy coverings of snow and so melt it with dangerous rapidity. Especially is this possible where there are extensive forests for the trees protect the snow from the rays of the sun so as to prevent its melting until well within the season of warm rain. This is the opposite of the role usually assumed by forests towards floods. The great flood of 1884 was caused by a heavy rain falling on a thick mantle of snow.

3. Deforestation. This has two phases: one is the run-off which is increased tremendously and the amount which ordinarily seeps into the ground, to be distributed over some weeks of draining, is decreased; the other is that the present slopes for the most part were developed under forested conditions and are steeper than would exist otherwise.

4. Man has played his part. Many of the cities are built upon the flood plain. Note, for example, all the cities of the Miami Valley. The houses have been built right down to the water giving the river little room to expand, and so in time of flood the waters are forced to pile up within the limited channel. Railway bridges have had their approaches built of earthwork to the last pier before the span across the channel. Concrete bridges of artistic but confining designs have been built. These tend to restrict the flood waters and to increase their height. Also many of the cities were placed on the sharp turn of a river or just below the entrance of a tributary or both.

The subject of flood weather is a complex study and is beyond the scope of this bulletin. Be it said merely that flood storms are those in which there is not only excessive but long-drawn-out precipitation. A storm that augurs a flood should be considered prognostically from the point of view of its depth of rainfall, the area it covers, the speed with which it is moving, the center of the storm area, and the season of occurrence. The severe flood of March, 1907, was due to a prolonged heavy rain, the presence upstream of a quantity of moist snow, and to a high temperature which lasted for two days and broke up the ice. The flood of January, 1913, had its origin in a few days of relatively high temperature which melted the snow. The flood continued as long as the temperature was high, in this case 70 hours. The terrible flood of March, 1913, was the result of two storms following each other in

quick succession and precipitating their rain on country already saturated from a two days' drizzle. The first storm was the same which created tornado conditions from Omaha, Nebraska, to Terre Haute, Indiana. This was followed by a rain storm which came unexpectedly from the southwest.

The flood of January, 1913, offered some figures which show how difficult the high stages of the Ohio River are to combat. At Wheeling the flood crest on January 9 stood 44.6 feet, 8.5 feet above the flood of 1884 and 8.6 feet above the danger mark. On January 15 at Cincinnati the crest was 62.2 which was more than 12 feet above the danger mark. In 1884 the water stood at 71.1 feet above low water while in 1913 it measured 69.8 feet above the same datum.

In 1913 the flood at Dayton resulted from an extraordinary rain over the 2,500 square miles of drainage basin which lay above the city on Miami River and on the two tributaries which there come into the Miami, the Mad and Stillwater. To show how excessive the rainfall was at Cincinnati, in the month of March 9.09 inches fell, whereas 5.19 inches of this came down between the 24th and 27th inclusive. At Columbus in the same respective periods 8.09 and 6.94 inches fell, although the annual rainfall of Columbus is but 36 inches. An estimate has been made that from the 22nd to the 27th inclusive, 56 billion cubic feet fell into Ohio stream basins on ground already sodden. This is equal to one-thirty-sixth of the average annual discharge of the Mississippi into the Gulf and would require a reservoir eight times as large as Great Salt Lake to contain the water.

*Precipitation in inches at selected stations in Ohio River Basin for
March 23-27, 1913*

No.	Station	Mar. 23	Mar. 24	Mar. 25	Mar. 26	Mar. 27	Total
1	Toledo.....	0.00	2.44	2.68	0.34	0.68	6.14
2	Circleville.....	0.20	1.50	2.00	2.30	0.40	6.40
3	Columbus.....	0.00	0.60	2.62	2.72	1.00	6.94
4	Cleveland.....	0.00	1.96	2.88	1.26	0.98	7.08
5	Sandusky.....	2.20*	1.58	2.05	0.95	0.40	7.18
6	Cincinnati.....	0.00	2.21	4.15	1.11	0.00	7.47
7	Dayton.....	0.50†	2.90	3.30	1.50	0.80	9.00
8	Bangorville.....	0.90	2.00	5.20	1.60	0.90	10.60
9	Marion.....	1.40	2.00	4.40	1.90	1.00	10.70
10	Bellefontaine.....	1.40	1.50	5.60	2.10	0.50	11.10

*Readings for 24 hours, midnight to midnight.

†Readings for 24 hours, 7 P. M. to 7 P. M.

The severity of the floods is to be shown by the fact that in one storm in Licking County 50 bridges went out and the water rose so rapidly that a train was stalled and submerged to the depth of 3 feet, the passengers being taken off in boats. Cincinnati has had 3,000 families turned from their homes precipitously and \$2,000,000 of damage done with a single rise of the waters. In 1913, Columbus had 9 square miles of densely populated flood plain submerged with a loss of many lives. Dayton had a large portion of her city flooded; the flood plain was submerged to the depth of 10 to 20 feet and nearly all highway and railway bridges were out of service. In the entire valley 400 people lost their lives and property damage exceeded \$60,000,000, not including depreciation of property values. This last has been estimated at \$150,000,000. Not only was Dayton affected but also Hamilton, Piqua, Troy, Middletown, Franklin, and Miamisburg.

DROUGHTS

Droughts as well as floods are of great importance even with agricultural considerations omitted. The drought of 1904 in the Ohio River Basin was the most serious on record. For seven months, navigation was practically suspended from Wheeling to Pittsburgh, while 13,000,000 bushels of coal was stranded waiting transportation. The South was suffering from want of coal (the drought included September and October) and yet it was necessary to put the miners on half time. Manufacturing industries which customarily received coal by rail were curtailed, as railways were unable to obtain sufficient amounts of boiler water to operate. Trains were equipped with tank cars, hauling the water from long distances and often using water with so large a sulphur content as to injure the boilers. Water supply on farms and for towns became very low, adding greatly to the fire risk.

NATURAL VEGETATION

The natural vegetation of a region is the truest meter of the combined effects of the various elements of physical environment, especially climate. The delicate reactions of temperature, sunshine, rainfall, snowfall, wind, slope, and exposure are best measured by the plants which are native to the region.

The climate of Ohio supports the Alleghenian forest province to a high stage of development. That is to say, the continental type of climate is admirably suited to develop the deciduous-leaved hardwood forest such as we have in the eastern United States and in temperate Asia. Had Ohio a much colder or warmer climate, or a climate of more or of less rainfall, or such an oceanic climate as prevails upon the Pacific coast, it would then have had an evergreen forest. It is, how-

ever, characterized by the ash, oak, maple, hickory, walnut, linden, shadbush, dogwood, tulip, poplar, horse-chestnut, beech, and ironwood.

Ohio now has its prairie areas, and prairie plants are in good force in the State. The "sweet" limestone soil of the western part of the State is especially favorable for their growth and indeed is instrumental in excluding from the flora a long list of plants common to the acid granitic areas of the Atlantic region. Ohio, though not so much as Indiana, is upon the tension line between the Alleghenian forest and the prairie province. Once again the State is a transition.

A southern element is distinctly and naturally felt in the Ohio Valley. It extends to a marked degree throughout the State and is reflected in the woody species by such trees as the cucumber (*Magnolia acuminata*), the coffee (*Gleditechia triacanthos*), the bladdernut (*Staphylea trifoliata*), the buckeye (*Aesculus octandra*), the silverbell (*Halesia caroliniana*), the persimmon and *Catalpa speciosa*.

The blackberry, raspberry, elderberry, cranberry, wild plum, and pawpaw (*Asemia triloba*) are all native. The buttercup, violet, anemones, spring beauties, trilliums, arbutus, orchids, columbine, laurel, honeysuckle, golden rod, and asters are the common flowers.

Bibliography on Climate

The material for the brief description of the climate, aside from general articles on the climate of the country, has come from data kindly furnished by Mr. William Alexander who is in charge of the Columbus Station of the United States Weather Bureau. The maps and charts are used by his permission. They are based on most recent data and are to appear in a climatological history of Ohio which Mr. Alexander has in preparation for the Ohio Agricultural Experiment Station. A short description of the climate of Ohio is "The Climate of Ohio" by J. Warren Smith (Ohio Agr. Exper. Sta. Bull. 235, 1912). The Monthly Weather Review (U. S. Weather Bur.) contains many articles on climate and agriculture. See particularly "Weather and Winter Wheat," (Dec. 1919, pp. 841-847); "Weather and the Corn Yield," (Aug. 1920, p. 439 et seq.); "Rainfall and Agriculture in United States," (Vol. 45, 1915, pp. 267-274). There are many helpful notes in "Agricultural Meteorology" by J. Warren Smith (1920).

A good discussion of floods in Ohio is to be found in reports of the Miami Conservancy District commencing in 1916 (Dayton). The following papers and reports take up the question: W. S. Tower, "The Mississippi River Problem" (Pop. Sci. Mon., July, 1908, p. 13 et seq.); A. J. Henry, "Rivers and Floods, March, 1913" (Mon. Wea. Rev., 1913, pp. 485-492); and "Destructive Floods in the United States in 1904," (U. S. G. S., Water Supply Paper 147), which also has a section on a drought in the same year. The Monthly Weather Review and the Water Supply Papers contain numerous articles and references to Ohio floods.

The most important article on plant ecology of Ohio is that which considers the economic aspects, "The Relation of Plant Succession to Crop Rotation" by A. E. Waller (Ohio State Univ. Bull., Vol. XXV, No. 9, 1921). Of the various studies of natural vegetation the best known are that of R. F. Griggs, "A Botanical Survey of the Sugar Grove Region," (Ohio State Univ. Bull., Vol. XVIII, No. 25), and "The Physiographic Ecology of the Cincinnati Region," by E. Lucy Brown (Ohio State Univ. Bull., Vol. XX, No. 34). I am indebted to my brother, Donald C. Peattie, U. S. Dept. of Agr., Bur. of Plant Industry, for assistance in ecological matters.

CHAPTER III

AGRICULTURE

EXTENT OF CULTIVATION

Not many years ago Ohio was the agricultural frontier of the country and an important granary. Though no longer a frontier it is still a notable agricultural region. Its soils should be looked upon as its most valuable asset, for it is to remain an important farm State.

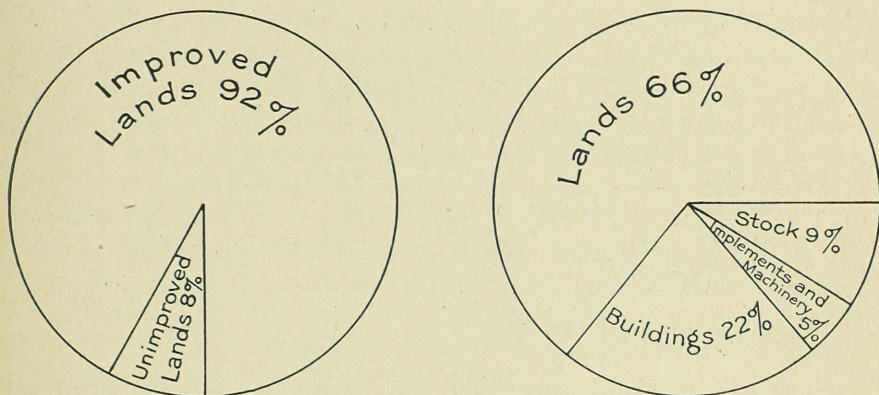


Fig. 14—A. Percentage of Farm Lands Improved in 1920
B. Comparative Values of Farm Lands and Equipment in 1920

The amounts of improved land in the different parts of the State vary with relief and to a less extent with the character of the soils and drainage conditions. There is little of Ohio which lacks sufficient fertility for the growing of one crop or another. Some rather extensive wooded areas still exist which may be cleared to advantage and the draining of lowlands is far from completed. The 23,515,818 acres of Ohio's cultivated lands are divided into 256,695 farms. Thus the average farm is 92 acres in extent. (Fig. 14, above)

Number of Farms and Per Cent Distribution by Size: 1880 to 1920

	1920	1910	1900	1890	1880
Total number of farms-----	256,695	272,045	276,719	251,430	247,189
Size group—					
Under 10 acres-----	15,867	20,197	17,347	12,325	11,163
10 to 19 acres-----	15,612	18,716	18,115	14,658	14,157
20 to 49 acres-----	44,535	50,331	57,566	51,846	49,465
50 to 99 acres-----	86,337	88,047	89,774	82,380	78,198
100 to 499 acres-----	93,511	93,859	92,837	89,036	92,645
500 to 999 acres-----	728	783	916	1,022	1,300
1000 acres and over-----	105	112	164	163	252
Per cent of all farms-----	100.0	100.0	100.0	100.0	100.0
Under 10 acres-----	6.2	7.4	6.3	4.9	4.5
10 to 19 acres-----	6.1	6.9	6.6	5.8	5.7
20 to 49 acres-----	17.3	18.5	20.8	20.6	20.0
50 to 99 acres-----	33.6	32.4	32.4	32.8	31.6
100 to 499 acres-----	36.4	34.5	33.5	35.4	37.5
500 to 999 acres-----	0.3	0.3	0.3	0.4	0.5
1000 acres and over-----	†	†	0.1	0.1	0.1

†Less than one-tenth of 1 per cent.

The largest farms, those over 1,000 acres, are not to be classed with the smaller ones from the point of view of productive importance per acre. This may be plainly seen from the following table of farm values, where it is to be noted that the medium size farm of 50 to 500 acres has the most valuable land. The percentages of improved land are the largest on the small farms.

Farm Acreage and Value by Size of Farm: 1920 and 1910

Size group (acres)	All land in farms (acres)		Improved land in farms (acres)		Value of land and buildings (dollars)	
	1920	1910	1920	1910	1920	1910
Total-----	23,515,888	24,105,708	18,542,353	19,227,969	2,661,435,949	1,644,152,406
Under 20----	309,944	363,977	269,835	327,189	104,365,453	81,009,747
20 to 49----	1,558,326	1,719,606	1,278,657	1,441,294	221,038,609	149,415,179
50 to 99----	6,372,019	6,444,930	5,191,712	5,288,437	752,479,545	454,592,415
100 to 174----	8,969,102	8,850,408	7,098,910	7,053,181	949,553,636	569,462,824
175 to 499----	5,677,796	6,020,366	4,297,908	4,641,288	572,502,799	360,285,828
500 to 999----	446,953	488,963	311,411	355,502	46,568,014	29,425,733
1000 and over----	181,748	217,458	93,920	121,078	14,927,893	9,960,680

Percentage of Improved Lands on Farms of Various Sizes: 1920

Average improved land in 1920.....	78.9 per cent
On farms under 20 acres.....	87.1
On farms of 20 to 40 acres.....	82.1
On farms of 50 to 99 acres.....	81.5
On farms of 100 to 175 acres.....	79.1
On farms of 175 to 499 acres.....	75.7
On farms of 500 to 999 acres.....	68.7
On farms of 1,000 acres or over.....	51.7

There are no distinct agricultural provinces in Ohio. However, a region characterized by corn and winter wheat may be set aside from a rather distinct pasture province by a line running northwest from Ripley, Brown County, to Columbiana County, then north to Trumbull County, west to Toledo, and southwest to Defiance County. The basis for this differentiation is topography so far as the south leg of the elongate pasture province is concerned. The northern part of the province is the result of the cooler climate, character of soils, and proximity to markets for dairy goods. The corn and wheat province may be subdivided, as corn prospers on the flat limestone areas of the west and wheat on the more hilly portions of the glacial plains, the terminal moraines, and other better drained areas.

Summary for All Crops: 1919

	<i>Farms reporting</i>		<i>Acres harvested 1919</i>	<i>Quantity 1919</i>	<i>Value 1919</i>
	<i>Number 1919</i>	<i>Per cent 1919</i>			
All crops.....					\$607,037
With acreage reports.....			11,780,554†		570,665
With no acreage reports.....					36,372
Cereals, total.....			8,200,784	259,547,851 bu.	391,834
Corn.....	225,568	✓87.9	3,563,352	149,844,626 "	217,274
Oats.....	137,099	✓53.4	1,452,052	46,818,330 "	36,795
Wheat, total.....	176,421	✓68.7	2,922,592	58,124,351 "	127,873
Winter.....	174,360	✓67.9	2,861,401	57,213,718 "	125,870
Spring.....	7,150	2.8	61,191	910,633 "	2,003
Barley.....	19,601	7.6	114,217	2,412,196 "	3,256
Rye.....	15,860	6.2	116,464	1,666,449 "	2,582
Buckwheat.....	6,523	2.5	30,413	640,662 "	993
Mixed crops.....	198	0.1	1,475	36,049 "	48
Other grains and seeds with acreage reports, total.....			4,641		281
Dry edible beans.....	2,058	0.8	2,122	16,792 bu.	105
Soy beans.....	735	0.3	1,753	17,441 "	100
Dry peas.....	138	0.1	627	11,254 "	53
Peanuts.....	40	--	18	627 "	2
Flaxseed.....	38	--	76	699 "	2
Sugar beet seed.....	7	--	44	34,867 lbs.	17
Seeds with no acreage reports, total.....				309,968 bu.	5,978
Red clover seed.....	13,443	5.2		89,961 "	2,788
Other clover and alfalfa seed.....	3,882	1.5		83,967 "	2,351
Timothy seed.....	7,613	3.0		122,470 "	710
Other grass seed.....	47	--		11,812 "	118
Millet seed.....	26	--		1,671 "	6

†Excluding 1,659,177 acres reported for corn cut for forage, which is practically all devoted in the acreage shown for corn harvested as grain.

Summary of All Crops: 1919—Concluded

	<i>Farms reporting</i>		<i>Acres harvested 1919</i>	<i>Quantity 1919</i>	<i>Value 1919</i>
	<i>Number 1919</i>	<i>Per cent 1919</i>			
and forage, total.....	222,068	86.5	4,917,259	7,661,890 tons	\$130,187,929
all tame or cultivated grasses.....			2,997,710	3,682,781 "	93,760,038
timothy alone.....	155,899	✓45.2	1,436,301	1,702,031 "	43,401,812
timothy and clover mixed.....	98,054	✓38.2	1,190,646	1,467,155 "	36,678,875
clover alone.....	25,194	9.8	250,010	300,680 "	7,517,000
alfalfa.....	17,831	6.9	94,418	187,904 "	5,637,120
other tame grasses.....	3,457	1.3	26,335	25,011 "	525,231
wild, salt, or prairie grasses.....	413	0.2	3,396	4,406 "	57,278
small grains cut for hay.....	4,455	1.7	19,751	20,875 "	438,375
annual legumes cut for hay.....	1,391	0.5	5,670	7,974 "	175,428
large crops.....	29,419	11.5	224,469	1,906,206 "	15,249,648
corn cut for forage.....	112,980	✓44.0	1,659,177	2,023,982 "	20,239,820
saffir, sorghum, etc. for forage.....	760	0.3	5,067	7,152 "	71,520
root crops for forage.....	535	0.2	2,019	8,514 "	195,822
vegetables, total.....					43,365,158
potatoes (Irish or white).....	144,203	✓56.2	124,917	7,513,960 bu.	17,657,811
sweet potatoes and yams.....	12,870	5.0	2,584	224,774 "	528,225
other vegetables.....	20,152	7.9	62,860		9,532,727
farm garden.....	224,807	87.6			15,646,395
miscellaneous crops, total.....					20,216,824
tobacco.....	20,294	7.9	75,789	64,420,472 lbs.	13,528,302
sorghum grown for sirup.....	12,217	4.8	5,464	24,256 tons	435,110
sugar beets grown for sugar.....	3,684	1.4	33,561	365,415 "	3,836,861
sugar cane grown for sirup.....	8,663	3.4			1,933,790
room corn.....	1,716	0.7	735	346,112 lbs.	24,228
peas.....	21	--	1,574	2,172,652 "	434,531
beans.....	11	--	10	2,526 "	17,682
dry minor crops.....			106		6,320
fruits and nuts, total.....					15,172,769
small fruits.....	19,581	7.6	9,447	11,963,128 qts.	2,359,379
other fruits and nuts.....					12,813,390

Cereals are the important crops of Ohio with hay and forage holding a strong second place. Dairying is carried on in all parts of the State but is especially important in northeastern Ohio. The acreages of the important crops are:

<i>Crop</i>	<i>1919</i>	<i>1909</i>	<i>1899</i>	<i>1889</i>	<i>1879</i>
Corn-----	3,563,352	3,916,050	3,826,013	3,189,553	3 281,923
Oats-----	1,452,052	1,787,496	1,115,149	1,215,355	910,388
Wheat-----	2,922,592	1,827,932	3,209,074	2,269,585	2,556,134
Hay and forage†-----	4,917,259	3,306,619	3,015,261	2,992,026	2,189,782
Potatoes-----	124,917	212,808	167,590	185,393	-----
Tobacco-----	75,789	106,477	71,422	44,303	34,676

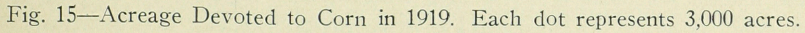
†Includes 1,659,177 acres in corn cut for forage. This crop was not included to any extent in the hay and forage totals prior to 1919.

CEREALS

Corn.—Corn is the historic crop of Ohio, for the State was an important producer before the coming of the white man. John Rogers Clark burned 200 acres of corn about the towns of Piqua and old Chillicothe in 1782, during a punitive expedition against the Indians and on the same expedition enormous quantities were burned at Loramie's store. In 1790, 20,000 bushels was seized and destroyed at the headwaters of the Miami.

The manner of corn planting was such that it was *par excellence* the crop for the dead (ringed) timber lands. Since the first settlements it has been grown in all parts of the State, though in the hill country it is confined more largely to the rich bottom lands. In the seventies corn increased in acreage decidedly, due to improved methods of culture and to the invention of modern farm machinery. An area of decrease today occurs in the eastern part, whereas in the western half there is an increase and Clinton and Greene counties lead in production.

Ohio is at present the fifth corn State in the Union. In 1919 it produced 149,844,626 bushels and 79.9 per. cent of the farms were growing corn. It is the great crop of the western part of the State owing to limestone soils with high humus content and to level land. Originally grown extensively in the southeast, there was a natural migration to the west as soon as settlements were complete, because here it found its natural habitat. In this section 78 per cent of the corn is produced now. Because of this, swine and cattle are more important in the west than are sheep. Dairying in the corn province is extensive only near the larger cities. The counties of the northwest



have less corn because of the increasing acreage in that region given to oats, a crop which fares better in that cooler climate. Considering Darke as a typical corn county, we find in 1920 there were 95,691 acres given to it, 34,244 to oats, and 55,069 to wheat. These with other cereals made a total of 190,497 acres, whereas 103,220 acres were devoted to forage crops—principally timothy and clover mixed; 1,666 acres to potatoes; 246 acres to other vegetables; 13,312 acres to tobacco; and 490 acres to sugar beets. The stock on the farms were predominantly swine. (Fig. 15, above)

Corn Production by Decades: 1850 to 1919

	<i>Average acreage</i>	<i>Average yield per acre (bushels)</i>
1850-59.....	1,967,160	33.13
1860-69.....	2,152,117	32.25
1870-79.....	2,733,695	36.90
1880-89.....	2,698,140	33.86
1890-99.....	2,861,653	34.30
1900-09.....	3,028,294	36.56
1910-19.....	3,149,655	37.10

Wheat.—The wheat of Ohio is chiefly the winter variety. In 1919 the production amounted to 57,213,718 bushels whereas the spring wheat totaled but 910,633 bushels. From 1839 to 1899 Ohio stood high in the production of wheat but the yield has not increased in anything like the proportions of that of the corn crop. Wheat is the mark of an agricultural frontier for it is easily transported and does better on virgin farms than on much used soils, unless they are scientifically treated. Then, too, corn has offered economic competition, as wheat can be grown in drier regions than corn and hence a State so well watered as Ohio is more characterized by corn than by wheat. Also, Ohio stands nearer a critical climate in regard to wheat than to corn. The June and July maximums of rain are too late to help the growth of wheat and may damage the crop considerably. In 1845 the wheat crop was a failure due to a drought, to the midge, and to a winter killing; and in 1859 wheat suffered from a late June frost, especially in the north. For such reasons its cultivation was problematical for a number of decades in the last part of the nineteenth century and the increase during that time was entirely due to the opening up of new farms. Wheat production today is more stable owing to the selection of better varieties, to better tillage, the use of fertilizer and the better understanding of the value of crop rotation.

The original wheat belt was in the "back-bone" counties, and Stark, Richland, Wayne, and Ashland distinguished themselves by their production. These, with Morgan and Belmont counties, constituted the old wheat belt. The habit of wheat growing there remains strong and it is produced in rotation with oats and clover to the partial exclusion of corn. There is now a second area where wheat enters into the rotations so persistently as to form another center of production, e. g., Darke, Preble, Miami, Montgomery, and Greene counties. There is also a lesser center about Fairfield, Pickaway, northern Ross, and the southern half of Franklin counties. The north of the State is at

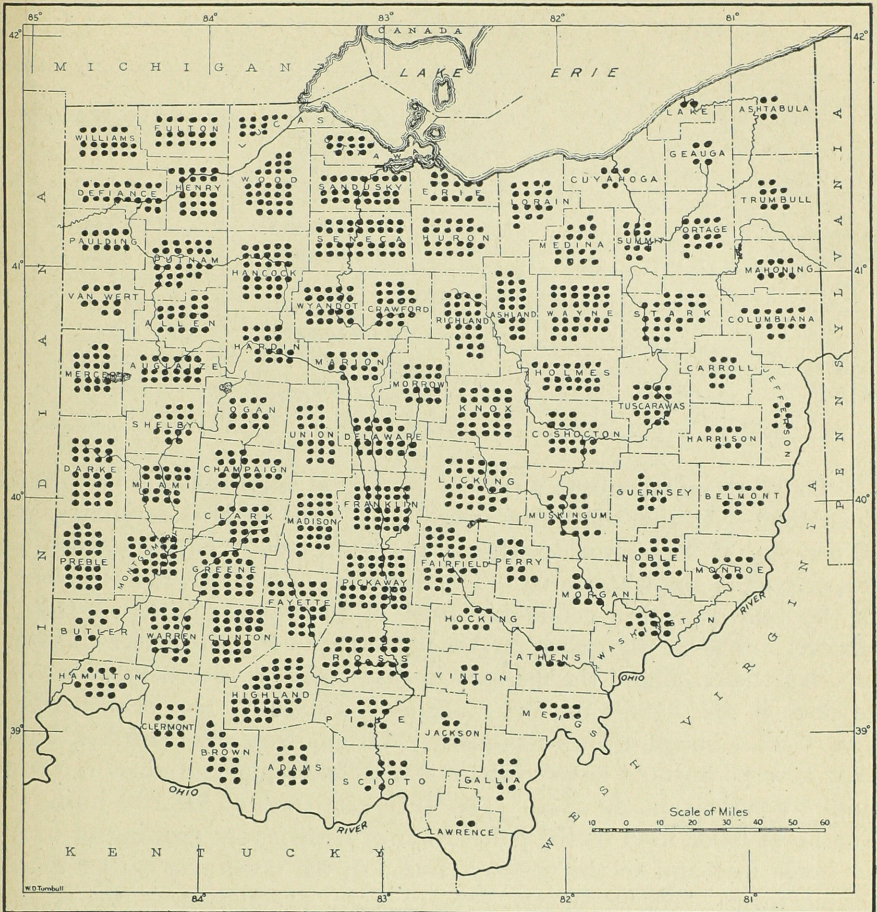


Fig. 16—Acreage Devoted to Wheat in 1919. Each dot represents 2,000 acres. Computed to the nearest 2,000 acres.

times referred to as the "wheat belt" but this is because of its greater production per acre; it is in the southwest that the greater portion of the State's total is obtained. (Fig. 16, above)

Wheat Production by Decades: 1850 to 1919

	<i>Average area (acres)</i>	<i>Average yield per acre (bushels)</i>
1850-59.....	1,625,402	12.21
1860-69.....	1,645,321	11.21
1870-79.....	1,822,546	13.26
1880-89.....	2,532,681	13.70
1890-99.....	2,520,402	14.63
1900-09.....	1,977,248	14.60
1910-19.....	1,752,982	16.60

Oats.—Oats have been a crop of increasing importance in the State since 1850. At that time they were sown over an area estimated at 39 per cent of that given to wheat; now they occupy an area which is 68 per cent of the wheat area. The distribution is somewhat the same as the two crops are commonly used in the same rotations. Oats, however, are generally grown farther north than corn, the cooler climate favoring the crop, and the increase in that region is responsible for the advance in the figures for the State as a whole. A line drawn from Van Wert through Upper Sandusky, Marion, New Philadelphia, and East Liverpool would have to the north all the regions producing more than 30 bushels to the acre. The 1919 crop was 46,818,330 bushels. The horse labor used in the cultivation of corn favors growing of oats for horse feed and so this grain is found in the northwest rather than the northeast, because of the greater corn production of the west. (Fig. 17, p. 39)

Oats Production by Decades: 1850 to 1919

	<i>Average area (acres)</i>	<i>Average yield per acre (bushels)</i>
1850-59.....	637,067	17.88
1860-69.....	713,749	25.60
1870-79.....	917,177	27.73
1880-89.....	871,876	30.40
1890-99.....	993,226	29.13
1900-09.....	1,326,323	31.88
1910-19.....	1,539,474	35.60

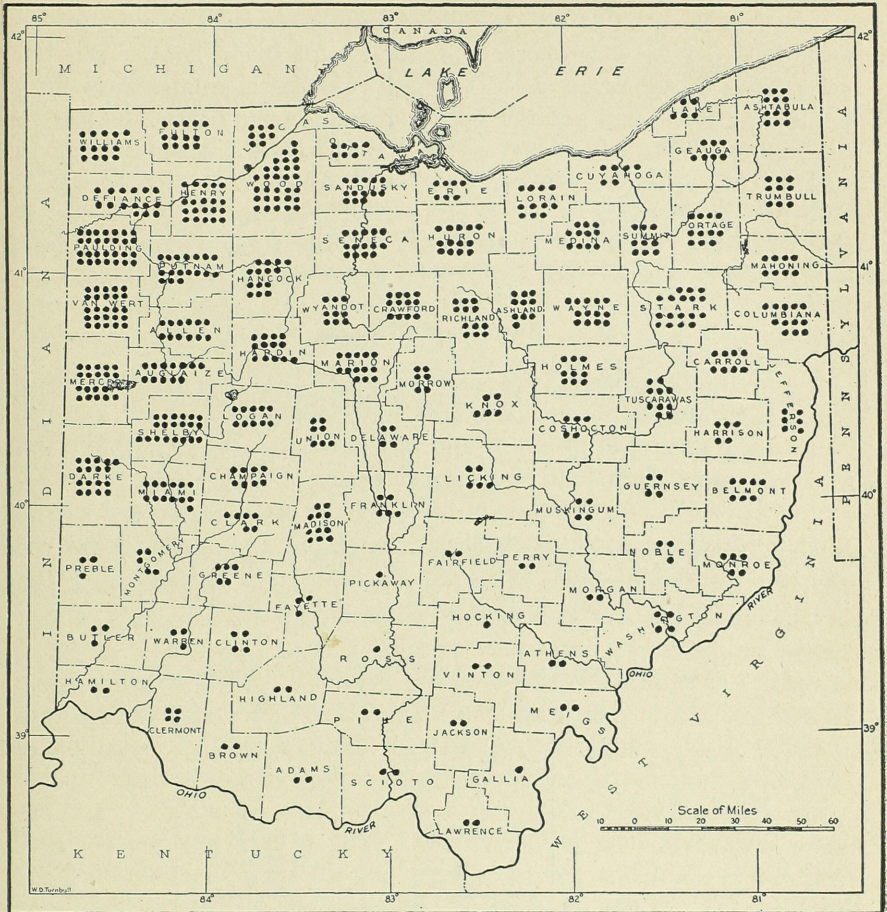


Fig. 17—Acreage Devoted to Oats in 1919. Each dot represents 2,000 acres. Computed to the nearest 2,000 acres.

Barley and Buckwheat.—Barley was grown extensively in the southwest corner of the State and in Erie County from 1880 to 1889; but at the present time all the barley is produced in the extreme northwest corner. Since 1850 it has been disappearing and in that time has increased only in 13 counties of the northwest as it is adapted to the more continental climate of that section. Rye culture is confined to glacial soils almost entirely and is grown where land is too poor for other cereals or where a farmer fails to get wheat in the ground because of weather conditions. Of the 8,200,784 acres which in 1919 were devoted to cereals, rye occupied 116,464 or less than two per cent of the total. In the same year the total yield of cereals was 259,547,851 bushels and the rye yield 1,666,449 bushels. Buckwheat on a farm in Ohio either marks it as new land or wet land. Occasionally it is sown where the soil is prepared too late

for corn or oats. The opening up of new lands from east to west has been followed by a temporary production of buckwheat. The buckwheat area of Ashtabula and Trumbull counties is greater than for the rest of the State and yet the total acreage for the State was less than the oats of Ashtabula alone. The State yield of buckwheat for 1919 was 690,662 bushels, coming from land which does not "warm" in time for the planting of other crops. One cannot help noticing that the buckwheat counties immediately adjoin those counties (Geauga and Portage) wherein are by far the greatest number of maple trees.

HAY AND GRASS

Of the total acreage of the four principal crops—corn, oats, wheat, and hay, something like 30 per cent is in hay, including clover. Ashtabula County is a great hay producer and hay and clover in Trumbull County represent more than half of its total acreage. Ashtabula had 22 per cent of her 1919 crop acreage in hay and the land so devoted was notably productive. Comparisons are made in the table below with counties which had approximately the same hay acreage in 1919 as Ashtabula and Trumbull. The table speaks for itself.

Hay Production per Acre in Four Counties: 1919

<i>County</i>	<i>Acres harvested</i>	<i>Tons</i>	<i>Tons per acre</i>
Seneca-----	87,934	112,171	1.27
Ashtabula-----	83,170	170,019	2.04
Adams-----	63,820	68,381	1.07
Trumbull-----	66,373	157,679	2.77

This centering of hay production is due in part to the lower summer temperatures and lower evaporation in the north which combine to make effective the rainfall for the continuous growth of untilled plants. The extent of the localization of hay is well shown in the following table for 1915:

Hay Production: 1915

Northeast section-----	842,223 tons
Northwest section-----	646,898
Southeast section-----	454,611
Southwest section-----	297,029

Clover, on the other hand, is confined largely to soils with a limestone base for it is in the non-acid soils that the nitrogen-gathering bacteria with which the clover is inoculated thrive best.

Clover Production: 1915

Northwest section-----	387,497 tons
Northeast section-----	120,500
Southwest section-----	144,318
Southeast section-----	43,901

Alfalfa is grown extensively and almost exclusively in the Miami Valley, especially in Hamilton County. The reasons for the decided concentration of alfalfa are not so much geographic as the result of the influence of a pioneer in this crop. Of the five counties cutting appreciable amounts of wild grass it is interesting to note that three are grouped in the northeast, Geauga, Trumbull, and Ashtabula, where there is much level undrained land. The other two are Noble and Hamilton counties.

FRUITS

Ohio has produced apples since the days when Johnny Appleseed roamed the virgin forests planting seeds wherever he found a clearing. This benevolent, half-mad pioneer had a vision of the settlers who were to follow and rejoice to find the ripe fruit upon the trees but even his imagination could hardly have pictured the thousands and thousands of orchards of today. Ohio is an apple State and of the 182,573 acres in fruit trees in 1920, 175,416 were devoted to apples. It is interesting to note that Ohio has fallen off rapidly in the production of apples for the last two decades. In 1910 there were more than 8,000,000 trees of fruit-bearing age and in 1920 there were less than 6,000,000. There are a number of causes for the decline, among which are the improvement of transportation and the competition offered by far-western apples and the ravages of pests which cause the farmer to spray just at plowing time. In 1880 trees were evenly distributed over Ohio. Today the growing of fruit has taken on a more centralized form and apples have decreased notably in certain districts. A line drawn from the northwest corner of the State to the mouth of the Scioto has southwest of it a region of highly specialized farms in which apple culture is conspicuously lacking as the land is mostly so level that it can be used more advantageously for other purposes. The hilly sections, glaciated and unglaciated, are well supplied with orchards and the most famous of Ohio apples, the Rome Beauty, comes from the hills of Rome Township, Lawrence County. Indirectly the rough topography aids in fruit growing for the hillsides are notably free from frost. Also the poorer farmers of the hills produce apples for their own consumption while the more prosperous farmer of the plains will not trouble with a small orchard but will buy his fruit. However, the significant yields of apples in the hills are not due to this economic independence of small farms

but to orchards created by large investments. The rate of increase of trees in this region is prophetic for the future.

One area of the plains province, Delaware Township of Delaware County, produces more apples than any other township of the State. This is due not so much to geographic factors as to a Frenchman who settled here and planted an orchard on ground that had been used for a long period as a feeding lot for cattle and was therefore exceedingly fertile. His orchard became very fine and was visited by pomologists from coast to coast. He gave an impetus to the industry which resulted in the record conditions for the township.

This tendency towards concentration of a crop because of some pioneer in the work having been successful is characteristic of agriculture as with other industries. One learns by example and is encouraged by the prosperity of his neighbor. A commission merchant establishes himself and the market comes to the farmer instead of his seeking out the market. A last stage is the co-operative marketing and the formation of societies.

Apple Orchard Acreage by Decades: 1860 to 1919

	<i>Average area (acres)</i>
1860-69.....	346,918
1870-79.....	397,622
1880-89.....	385,476
1890-99.....	372,011
1900-09.....	282,867
1910-19.....	213,949

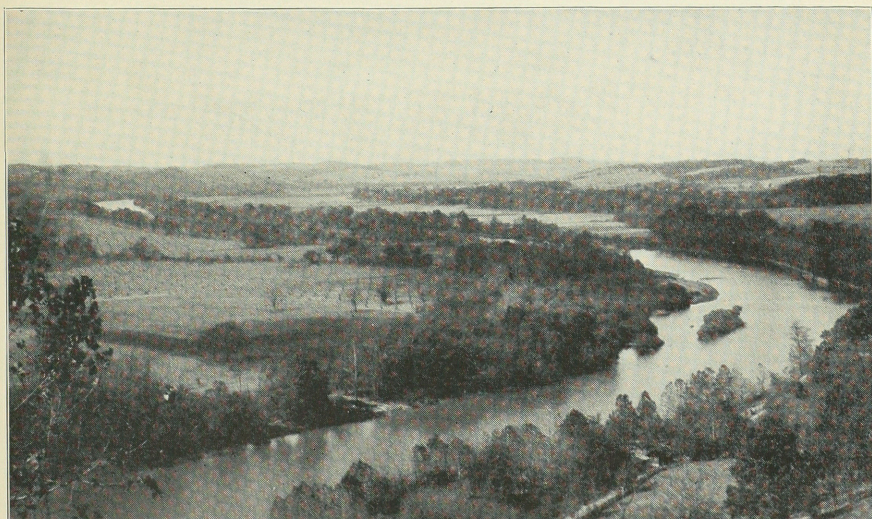
Apple Production by Decades: 1860 to 1919

	<i>Average yield (bushels)</i>
1860-69.....	10,540,962
1870-79.....	14,393,175
1880-89.....	14,523,096
1890-99.....	7,484,550
1900-09.....	6,492,510
1910-19.....	7,409,193

Large peach orchards have been developed along the lake shore where modifying influences of the water prevent untimely destructive frosts. The zone is a relatively narrow one as the influence is decidedly local. Pears, plums, cherries, and to a lesser degree quinces and mulberries complete the list of tree fruits. There were in 1920 even two fig trees bearing fruit. The following table not only shows the proportional importance of the various fruits but points out a significant decrease in the last decade.



A—Hill farms in Monroe County. Elsewhere in southeast Ohio the country may be rougher, and in places consists of narrow ridges and deep valleys. The house in the foreground is of logs. (Photo by Stauffer)



B—The Muskingum Valley near Dresden. This is a wide valley cut into the uplands of Ohio. The bottom lands constitute some of the best acres in the State. (Photo by Stout)

Percentage of Farms Reporting Trees of Bearing Age: 1920 and 1910

	1920	1910
Apples-----	68.3	73.9
Peaches-----	26.3	37.8
Pears-----	32.0	41.9
Plums and prunes-----	24.3	35.4
Cherries-----	39.5	43.3

Grapes are a much localized crop. They are important only within the belt of immunity from late spring frosts on the border of the lake. In 1920 there were 13 counties each of which had more than 25,000 vines of bearing age. Belmont with 38,274 bearing vines and Hamilton with 77,016 were the only counties of more than 25,000 vines outside of the lake belt. Of the lake counties with more than 25,000 vines of bearing age six contained 92 per cent of the total, Cuyahoga alone having 1,480,827 bearing vines and Ottawa 1,051,439. Whereas previously one-fourth of the output of grapes was sold to wineries, that market is now closed. In 1910 there were some 8,326,000 matured vines while in 1920 there were but 6,554,000 and the production of grapes fell off from 43,933,000 pounds to 41,723,000 pounds. However, the value of the crop jumped from \$853,600 to \$2,920,600 in the decade.

Small fruits (strawberries, blackberries, and raspberries) show the same tendency to concentrate as do other fruits. Like garden vegetables they concentrate about large city markets. Cleveland, Sandusky, Toledo, Dayton, Cincinnati, and Columbus all have their centers. Small fruit for Columbus is not grown in its own county so much as in the adjoining county of Fairfield. Columbiana County, though without a large city, produces large amounts, relying upon the comparative proximity of a number of important counties. Strawberries have a large center of production in Lawrence County.

OTHER CROPS

Potatoes and tobacco are of large importance. Potato growing centers are very distinct: the group of counties, including Portage (the most productive), Stark, Wayne, Medina, and Summit, forms by far the greatest potato center of the State. Four other counties devote considerable acreage to this crop and each of these has in it a city. They are Cuyahoga (Cleveland), Erie (Sandusky), Lucas (Toledo), and Hamilton (Cincinnati). If the State be divided into quarters the north-east with its large crop of potatoes would have in it as markets one city of more than 500,000 persons, two of more than 100,000, one of more than 50,000, six of more than 25,000, and ten in excess of 10,000. Successful potato growing is a matter of soil, climate, and nearness to market. This vegetable survives a wider range of climatic conditions

than of soil requirements. That sandy loam is good for potato culture is well known, but the proximity of markets is no less important. Also like breeds like. If potato buyers go into a certain district expecting to buy potatoes the neighboring farmers turn their attention to raising a crop for this ready market.

Tobacco is a crop which has shifted geographically in a large degree since times of more or less complete settlement. In the sixties there were seven counties which had more than 1,000 acres devoted to this weed. Five of these were in the southeast, grouped about the lower Muskingum Valley, and two (Brown and Montgomery) were in the southwest. In the seventies there were ten counties over the 1,000 acre mark, six of which were in the southwest. Today the one area of significant tobacco culture is in that belt of the southwest which extends from Adams County to Darke. In 1919 the State grew 64,420,470 pounds on 75,789 acres.

Counties Devoting more than 3,000 Acres to Tobacco: 1919

Darke.....	13,312 acres
Montgomery.....	17,263
Clermont.....	7,525
Brown.....	7,257
Adams.....	6,798
Preble.....	5,189
Warren.....	3,000

The shift in growing of tobacco has come about through the impoverishment and erosion of the soils of the hilly country, which now has difficulty in competing with the glacial plains to the southwest. The famous Kentucky burley tobacco is grown in Adams County which essentially repeats the soil conditions of the Blue Grass country.

Sugar beets have possibilities which are as yet undeveloped. The production is such that it must be carried on within short distances of the sugar mills as the beet is too bulky and heavy for long distant hauls. Also there is concentration of the industry due to soil properties and the greater number of hours of sunlight in summer to be found to the north. The twelve counties in the northwest corner of the State grow all the sugar beets. This extension of the Michigan field has been taking place since 1900. In 1919 there were 3,684 farms giving over a total of 33,561 acres to the beet and these grew 364,416 tons of beets. This is in contrast to the planting of sorghum for sirup in which four times as many farms took part, but which on one-seventh the area produced one-fourteenth the crop in tons. The value of the land, acre for acre, was of course much less than in the case of beets and there was nothing like the same concentration of production, for the sirup of sorghum is made on the farm.

Maple trees to the number of 2,269,199 were tapped in 1919, which was one million less than the number in 1909, one-third of the farmers not tapping their trees in 1919. The value of the sap drawn was increased in the decade, however, from \$1,099,248 to \$1,933,790. Sugar groves are concentrated to a large extent in Geauga and Portage counties.

STOCK RAISING AND DAIRYING

Sheep and Wool.—Sheep and wool growing are of great interest in Ohio because of the one-time importance of the industry. From 1840 to 1850 the sheep population nearly doubled but the climax was reached in 1850 when two things militated against the wool industry. The first was a demand from the land for other crops, especially cereals, and the second was the severe competition which the huge ranges of the far west brought about as soon as they were opened. From 1850 to 1870, however, Ohio had more sheep than any other State of the Union. In 1880 California took first place; in 1890 Texas was first and Ohio second; in 1900 Montana, Wyoming, and New Mexico were ahead of Ohio. In each case sheep raising has been carried on as a frontier industry. There were a variety of non-geographic factors which played effective parts, as the price of wool, the development of new breeds of sheep, and organization of growers. The improvement of transportation has hindered rather than developed Ohio wool growing for in the early forties, before the extensive building of railways, wool was the crop most easily stored and shipped by the slow and primitive methods of transportation of the time. Railways favored the wool of the cheap ranges of the western United States and permitted severe competition to Ohio farmers. Today there are no more sheep in Ohio than there were in 1840, which is a decrease of 50 per cent from the maximum once maintained.

The future of the sheep industry lies in the more careful economy of farms which is being forced upon the State due to the increased population of the country in general. Within a short time all the available land will be developed to its utmost. Also the tendency towards specialization in agricultural production will to a degree have ceased. Countries and counties will not tend to be single-cropped but will seek the most economical crop for each patch of ground. It seems relatively certain that sheep raising will increase in Ohio in order to utilize steep slopes, lands with water tables unsuitable for plant raising, woods, and stony lands. The industry tends to expand most in the southeast of the State. At present, however, this region has but a slight ascendancy and does not represent the area of greatest production which is in Harrison County and in a belt running from Morgan and Noble counties to Wyandot. Sheep have declined in the hill country principally because of sheep-killing dogs and because dairy cattle have

forced sheep from the pastures, which last is especially true in the north-eastern part of the State. Corn-fed swine and beef cattle are found in the southwest to the exclusion of sheep.

Development of Sheep Industry: 1840 to 1920

<i>Year</i>	<i>Number</i>
1840.....	2,028,401
1850.....	3,942,929
1860.....	3,546,767
1870.....	4,928,635
1880.....	4,902,486
1890.....	4,060,729
1900.....	2,648,250
1910.....	2,890,163
1920.....	2,112,798

Swine.—A line passing through the center of the State north and south marks the eastern limit of the corn belt. After 1850, when there was a significant development of the corn crop in western Ohio and in the States to the west, the decrease of swine east of the middle of our State began and western Ohio increased materially in the number of hogs. Today all the important swine states are corn belt states with the exception of Texas. By 1870 the relation of corn lands to the west of the Scioto Valley to lands to the east was already becoming marked. From 1870 to 1880 Ohio swine population doubled. Hancock County reported 28,299 hogs in 1870 and 74,799 in 1880. As hogs are a by-product, the number has not increased in the west half since the establishment of farms in numbers approximate to those of today. Considerable numbers of all types of domestic animals are classed by the census as not on farms and are therefore not represented in any of the tables given here, but swine represent the largest group of the farms. In 1920 there were 113,606 head of swine in the State not on farms.

Development of Swine Growing on Farms: 1850 to 1920

<i>Year</i>	<i>Number</i>
1850.....	1,964,770
1860.....	2,251,653
1870.....	1,728,968
1880.....	3,141,333
1890.....	3,275,922
1900.....	3,188,563
1910.....	3,105,627
1920.....	3,192,452

Cattle.—In 1850 Ohio was the single important cattle State west of the Atlantic States. By 1900 eighteen states over the country had

more than 1,000,000 head and Ohio stood tenth in the list. Today the number of cattle is nearly 2,000,000 valued approximately at \$119,000-000. The industry has two phases: the raising of beef cattle and maintenance of dairy cattle.

The raising of beef cattle assumed a relatively large importance in the early history of the State and Cincinnati became one of the chief meat packing centers of the country. As many of the cattle came on foot to slaughtering houses there was a great tendency to localize beef animals. Geographic conditions which support raising of beef cattle today are two: hilly pastures and production of corn. Those cattle fed on corn are frequently brought from the western plains and fattened before shipment to market. The few counties which do raise greater numbers of beef than of dairy cattle are Morgan in the hills and Logan,

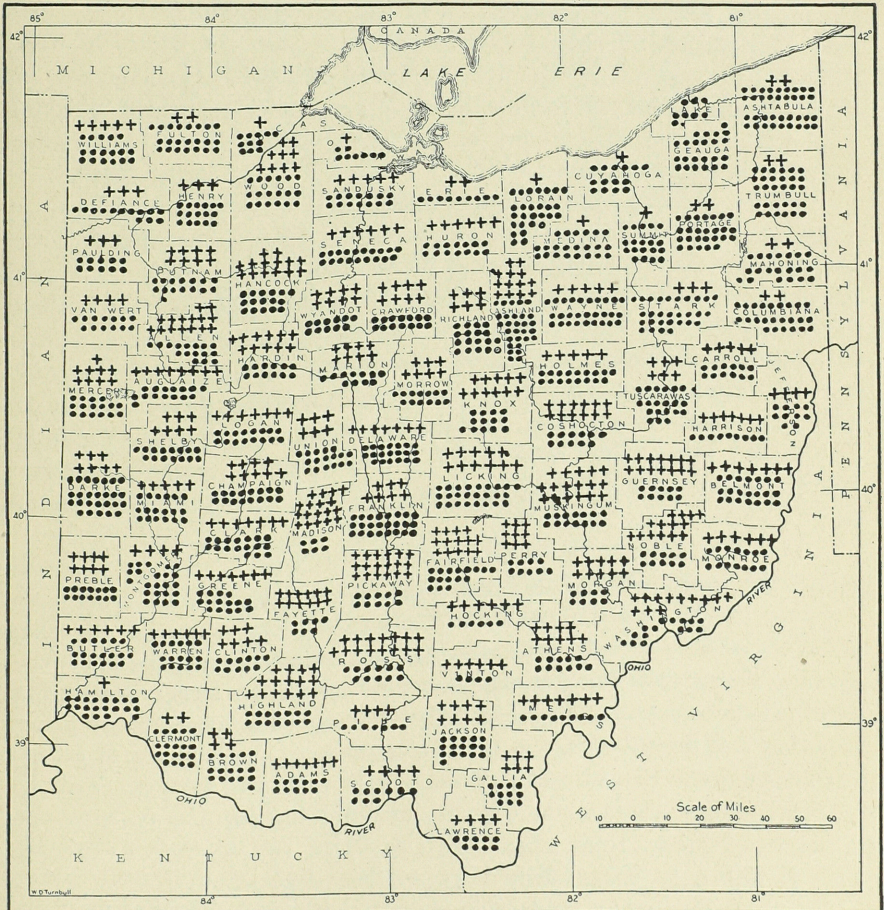


Fig. 18—Distribution of Beef and Dairy Cattle in 1920. Each check represents 1,000 beef cattle and each dot 1,000 dairy cattle. Computed to the nearest 1,000 cattle. Note the increase in dairy cattle about the cities.

Highland, Ross, and Pickaway in the corn belt. Not one of these is near a great center of population. There were in 1920 some 577,450 beef cattle in contrast to the 1,349,373 dairy cattle. (Fig. 18, p. 47)

Dairy Products.—Ohio first appeared as a dairy State through its cheese output. In 1849 there were something less than 544,000 cattle and yet 20,819,542 pounds of cheese were made. Northeast Ohio was settled chiefly by people of New England with cheese-making traditions. As it was a "money crop" which could be easily transported it formed a basis of early wealth. In the early forties when the entire output of the United States was 3,000,000 to 17,000,000 pounds, Ohio alone was producing more than 1,000,000 pounds. In 1848 the Western Reserve (the northeast of the State) produced more than 15,000,000 pounds, chiefly for eastern markets. The wool industry which thrived in this territory in 1840, had, at the close of the next decade, entirely given away before the competition of the dairying industry. In 1849, 2,000,000 pounds of cheese were produced within the State, of which three-fourths came from the five northeast counties. Ensilage was not available then and winter conditions forced a cessation of dairying. It is worth noting that today by far the greatest amount of ensilage stored is in the northeast.

At the present time Ohio produces little cheese, for with the increase of city populations and the facilities for transportation, butter and milk are found to pay better. Nearness to markets is a dominating factor in the dairy business, especially in the case of milk. It is therefore fortunate that some of the best land for pasture occurs in and about the densely populated section of the northeast. The dairy receipts from the triangle enclosed by a line from Vermilion (Erie County) to where the Ohio River first forms the border of the State are far in excess of any other equal area in the State. There are small regions of relative importance in dairying about Toledo, Cincinnati, Columbus, and Dayton. (Fig. 19, p. 49)

The development of transportation and, within the last three decades, the large increase of urban populations have not only made the dairying of the State of wide importance but have changed the character of the output until milk, butter, and butter fat are the important items. Those sections making cheese are doing so largely because of tradition and custom. Because of betterment of milch cows by proper breeding and new stocks, the rate of increase in the number of cows is not an adequate measure of the increase in milk and butter. This improvement of stock has come about since 1880 as has the improvement of winter feeding, thus increasing the dairy resources tremendously. This is not only accomplished by ensilage but by mill feed. Maps which show the butter and milk produced indicate a rather even distribution but not so with maps of dairy receipts, which, as would be

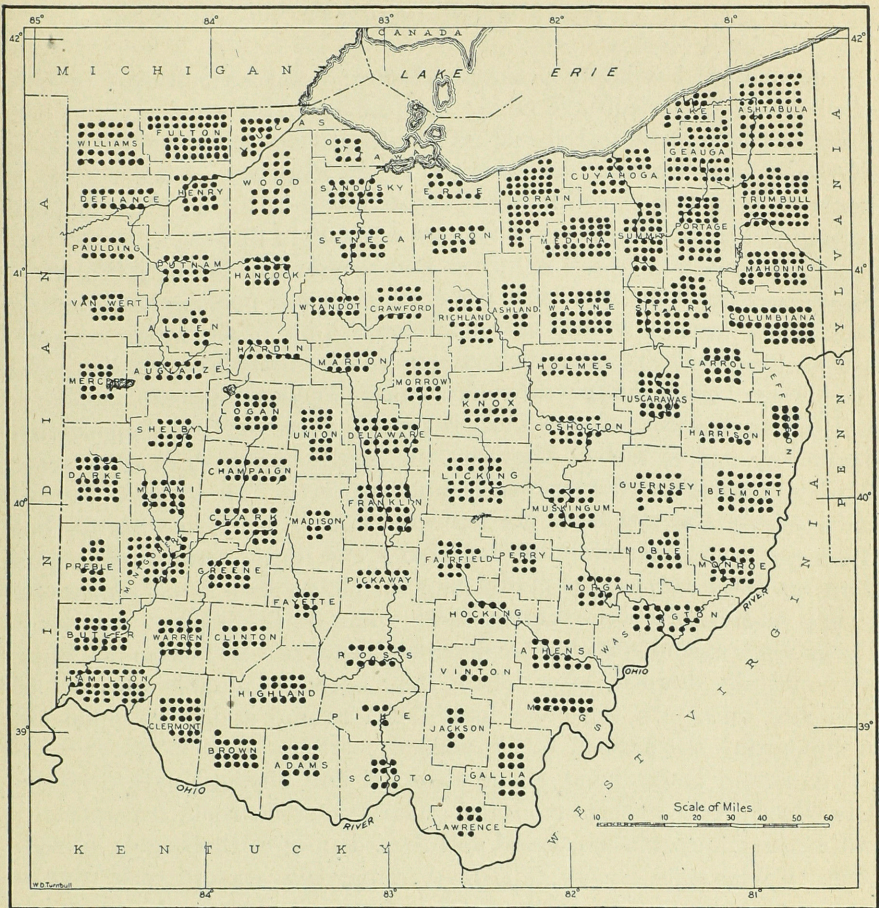


Fig. 19—Dairy Receipts in 1919. Each dot represents \$200,000. Note the falling off of receipts with increasing distance from cities. The northeast counties make most of the cheese of the State.

expected, are heaviest about cities as Toledo, Cleveland, Columbus, Dayton, and Cincinnati, and those of the northeast.

Present tendencies in the dairying industry are towards the centralization of manufacture. Butter, cheese, and condensed milk factories by their inroads on the milk supply have caused since 1900 a decrease in the amount of butter made on farms, whereas cheese made on farms in 1889 exceeded that made in either factory or on farm today. In 1904 the condensed milk plants alone were consuming 1,947,218 pounds of milk and in 1909 the figure had risen to 37,655,347 pounds. In 1919, milk produced was 347,869,655 gallons; value of dairy products was \$81,148,586; receipts from the sale of dairy products was \$72,539,099.

THE ROLE OF GLACIATION

Glaciation has had a pronounced effect upon agriculture. Indeed, glacial Ohio is agricultural Ohio. Almost exactly three-fourths of the State was glaciated and the other one-fourth produces but one-eighth of the crops. The matter, however, is not simple, and it certainly is not a mere matter of soil fertility, for involved in the question are historical and economic factors which are difficult to discern.

The most significant influence of glaciation is through the effect on topography. For the most part, the glaciated portion has a gently undulating surface, which, except in the vicinity of the larger streams, can all be tilled. This has two phases which should be brought to the attention. One is that an entire farm may be plowed without difficulty, and the second that after a farm is plowed there is little danger from destructive soil erosion. Also, the ice deposited the drift to a great depth and hence areas of exposed bedrock are few. There are, of course, areas within the glaciated portion which are gravelly or sandy, but these are comparatively rare in Ohio. The most serious deduction from the total area of the plains for non-tillable acres is on account of swamp and other poorly drained lands common to glaciated countries. These occur principally in the northwest counties and are now being systematically drained, after which they become valuable because of their rich soils. On the other hand, such swamp areas as remain aid in supporting the ground water table.

A second major point is the chemical and physical nature of the soils which the ice sheet deposited. Glaciers erode rock, transport it, and in the transportation, grind and then deposit it thoroughly mixed. Hence glacial soils consist of ground or partially ground rock from a variety of sources. In counter-distinction to soils deposited by running water, they are not sorted according to size of particles or chemical composition, but are thoroughly mixed. It has long been claimed therefore that because glaciated regions are very productive, that their soils have greater fertility than those of the driftless area. This is but true in part. The main significance of glaciation lies in the fact that it has distributed a soil of something like average fertility over hill and valley, until pre-glacial relief is more or less obliterated, and a topography results such as is found in the west part of the State.

The glacier has indirectly benefited the unglaciated section of the State. All the south-flowing rivers, more particularly the Muskingum, Licking, Hocking, and Scioto, were agents in carrying the finer materials of the drift down pre-glacial valleys and thus formed broad flood plains of the best constituents of the drift. Today these rivers have incised themselves into alluvial plains leaving broad terraces for farm lands. Zanesville, Marietta, Lancaster, Gallipolis, Ironton, and Portsmouth are some of the cities which have used these shelves as building sites.

As the soils in the unglaciated section are a function of slope, much of the best tillable land in this area is found upon the level river terraces. Indeed within Washington County alone there are 32,650 acres of such land.

In 1910 the unglaciated section of the State had 91.2 per cent of its land in farms, whereas the glaciated section maintained 93 per cent in this manner. In the same year 73.6 per cent of the unglaciated section was improved acreage as contrasted with 82 per cent in the glaciated section. The effect of topography upon the condition of the land is best illustrated by Vinton County where but 60 per cent was improved. This is a county with an extraordinary amount of area in steep hill-sides. Fourteen per cent of the unimproved area was in woodland.

There has been a special study made of regions in the vicinity of Canton and Millersburg which contain about equal amounts of similar unglaciated and glaciated territory. Each region is, however, of less than 500 acres and generalizations and comparisons should be made with caution. In the two divisions of each region climate and topography (except in so far as affected by glaciation) are the same. Bedrock, nearness to market, transportation facilities, drainage (except as affected by glaciation), and other geographic factors bear equal weight in the two sections. The relative productivity is indicated by the table below:

Productivity of Adjacent Glaciated and Unglaciated Areas

	Bushels per acre							Tons per acre
	Wheat	Rye	Oats	Corn	Potatoes	Apples	Peaches	Hay
<i>Canton area</i>								
Glaciated-----	9.9	13.2	43.2	39.1	97.0	37.4	32.8	1.25
Unglaciated----	8.8	15.2	34.3	38.2	99.7	14.0	29.7	1.08
Difference---	1.1	2.0	8.9	0.9	2.7	23.4	3.1	0.17
<i>Millersburg area</i>								
Glaciated-----	9.0	11.2	33.7	35.4	94.8	70.4	25.0	1.17
Unglaciated----	10.2	7.6	31.5	37.2	72.8	69.4	23.7	1.10
Difference---	1.2	3.6	2.2	1.8	22.0	1.0	1.3	0.07

Apparently glaciated farms have a slightly greater fertility. Considered from the point of view of crop values, the effect of the ice sheet

is more marked. In the glaciated region the average value per acre of total farm land is higher.

Farm Values in Adjacent Glaciated and Unglaciated Areas

	<i>Total values</i>	<i>Total acreage</i>	<i>Value of products per acre</i>
<i>Canton area</i>			
Glaciated.....	\$5,238,780	204,022	\$25.60
Unglaciated.....	1,729,169	94,613	18.10
<i>Millersburg area</i>			
Glaciated.....	2,621,592	137,237	19.10
Unglaciated.....	2,348,581	142,980	16.50

The discrepancy is explained by the different percentages of cultivated land in the two cases, for the unglaciated area has much of its land in wood pasture. The Canton and Millersburg areas have respectively 68 and 65 per cent of their glacial lands under cultivation whereas only 32 and 46 per cent of their unglaciated areas are in that state. In spite of this fact, however, the live stock of the hill country, with the exception of sheep, is of less value than that of the area smoothed by the ice. Good feed other than pasturage is one factor in the case.

Live Stock in Adjacent Glaciated and Unglaciated Areas

	<i>Average values per township</i>			
	<i>Horses</i>	<i>Cattle</i>	<i>Sheep</i>	<i>Hogs</i>
<i>Canton area</i>				
Glaciated.....	\$81,847	\$54,098	\$1,434	\$9,682
Unglaciated.....	56,606	34,389	7,810	6,110
<i>Millersburg area</i>				
Glaciated.....	72,080	42,582	5,183	13,357
Unglaciated.....	51,250	32,997	7,452	7,291

The conclusions of the study are:

(1) The glacier did not as greatly increase the fertility as is popularly thought.

(2) The leveling effect of the glacier increased significantly the total value of the crops.

FARM VALUES

There are a great many non-geographic factors in the history of the land values of the State. Whatever may have been the fluctuations due to outside influences or to non-geographic factors, it is patent that in a State which is so nearly a geographic unit the *relative* values of lands in the various counties tell a story of purely local factors of soil, transportation, and competition. A list of general factors in land values includes (1) productive capacity, (2) degree of improvement, (3) regional land values, (4) age and extent of settlement, (5) stage of development of transportation, (6) general price of farm products, (7) competition offered by other regions. These factors present a variety of possible combinations. For example, the excellent "black swamp" land of the northwest was once low-priced, even for that early period. The productive capacity of the land was all that could be wished for, but the state of improvement was poor, as it was not cleared and needed draining; it was surrounded by lands that were cheap and as yet undeveloped; transportation was very poor, and though the price of farm products was fair when they reached market, the regions nearer the center of population, as in New York State, offered ruinous competition. Land in the "black swamp" region was selling at from 84 cents to \$2.50 an acre. It now represents some of the most valuable land in the State.

Average Value per Acre in Ohio: 1850 to 1920

(Averages are based on "all land in farms" in the State)

<i>Census year</i>	<i>All farm property</i>	<i>Land and buildings</i>	<i>Land alone</i>	<i>Buildings alone</i>	<i>Implements and machinery</i>	<i>Live stock</i>
1920-----	\$131.64	\$113.18	\$85.69	\$27.48	\$6.23	\$12.23
1910-----	78.93	68.62	53.34	15.28	2.12	8.19
1900-----	48.93	42.31	33.35	8.96	1.48	5.14
1890-----	51.20	44.96	-----	-----	1.26	4.98
1880-----	51.44	45.97	-----	-----	1.24	4.23
1870†-----	44.23	38.85	-----	-----	0.95	4.43
1860-----	37.91	33.12	-----	-----	0.86	3.93
1850-----	23.09	19.93	-----	-----	0.71	2.45

†Computed gold values, being 80 per cent of the currency values reported.

Questions of agricultural economics have been factors in the history of land values, as for example the wheat famine in Ohio, later the

development of cattle raising, and still later the invention of farm machinery. The construction of roads from 1797 on, the extensive digging of canals after 1825, and soon after that, the building of railways, all tremendously increased local farm values. The increase in farm values went on steadily until seriously lowered in 1880 by the development of the mid-west prairies and the high plains by means of railway construction. Lands were to be had in the west so cheaply that Ohio land would not sell for anything like the money put into it. Also cattle and sheep, and, with the use of modern machinery, grain were raised more cheaply in the west. It was only at the beginning of the twentieth century that local land values rose, but this was in accordance with a general tendency all over the country. The increase in population and the movement of its center towards Ohio raised the market values of farm products in this State and hence the values of the farms themselves. In the last decade the farmer has come to his own and he who has a deed to a quarter section of good Ohio fields is well off.

Today transportation is so universally good within the State that all rich land of the plains is valuable irrespective of situation but in the immediate vicinity of cities land has an increased value because of the intensive garden culture that is often practiced and because of its potential use as an industrial or residential site. All portions of Ohio, save the southeast, have easy transportation to city markets. In the hills of the southeast coal mining has been a large factor in the construction of railways but most wagon roads encounter steep grades immediately on leaving the railway town. Also, this section contains only three cities of between 25,000 and 50,000 and but five of between 10,000 and 25,000. This is but one of the factors in the great contrast in farm values between the southeast and the remainder of the State. This unglaciated portion which represents 25 per cent of the total area of the State has a value for farms which in 1910 was but 14.8 per cent of the total value. In the preceding decade when the glaciated farms had increased 68.5 per cent in value, the farms here had increased but 30.9 per cent. It was a period of development of local city markets and of improvement in farm machinery, both of which had a minimum effect upon the hill country. A comparison of Gallia and Butler counties is instructive as Gallia is in the hills of the southeast and Butler on the till plains of the southwest and both have about equal areas in approximately the same latitude. The following table compares their land values:

Comparative Farm Values for Gallia and Butler Counties in 1913

<i>County</i>	<i>Area in acres</i>	<i>All farm properiy</i>	<i>Land in farms</i>	<i>Buildings</i>	<i>Implements</i>	<i>Live stock</i>
Gallia---	287,360	\$12,159,034	\$6,871,853	\$2,854,942	\$607,178	\$1,825,061
Butler---	289,840	26,627,372	16,853,655	5,674,716	1,308,483	2,790,518

*Average Value Per Acre**Gallia*-----\$42.31*Butler*----- 91.80

EARLY CONDITIONS OF AGRICULTURE

Cultivation of the land is of long tradition in Ohio. Not only did the Indians plant seed and till the soil, but that little-known race which preceded the Indians, the Mound Builders, grew corn and collected the wild fruits. Director Mills of the Ohio Archaeological and Historical Society has collected from the mounds of Ross County quantities of corn, as well as beans, dried plums, the seeds of pawpaws and grapes, and a variety of nuts.

The Indians were decidedly agricultural but it was the squaw who did the tilling. She successfully raised corn, beans, peas, squash, Indian cucumbers, pumpkins, tobacco, and perhaps potatoes. Also the wild strawberry, cranberry, pawpaw, and plum were gathered. Indian agriculture did not include any stock raising as the only domesticated animal before the coming of the white man was the dog. The corn was planted where the timber had been killed, but not felled, by the simple process of "ringing" the bark. Along streams where the timber was thin the country in places was said to resemble "one continuous garden."

Conditions of early agriculture for the white man were extremely difficult. He came west hopefully. "Ohio was the land of milk and honey with wheat lands richer than those of the Island of Sicily. The bogs held enough cranberries to make tarts for all of New England, and as one rode through the country on horse-back one's knees were stained red with strawberries." But also there were three to five years of hard labor before the farm really supported the family. The forests were the great handicap and it was against this wall that the pioneer must first hurl himself. Not only was the labor arduous but in the forest lurked the dangers of wild Indians and wilder animals. True the woods had great value as fuel, and as building material for houses and also for boats for the down-river trade as far as New Orleans.

The continuous stretches and density of stand of the timber baffled all but the hardiest and after this had been removed there remained the building of roads. If it had not been for hunting and wild fruits the first years of settlement would have been even more critical than they were.

At the beginning of the nineteenth century a farm that was self-feeding was a success; but soon there became a surplus of produce and a demand for currency. The first cattle for eastern markets left Chillicothe in 1805, crossing the Alleghenies on the hoof, and this method continued until the development of railways and the beginnings of Cincinnati as a meat-packing center. During the early nineteenth century, large flocks of turkeys were driven overland to Baltimore. South of the watershed goods of all sorts were shipped to New Orleans by raft or keel boat after which the tedious and dangerous return journey was made on foot. These difficulties were offset by the great fertility of the soil. Enormous crops were produced with the minimum of effort. As soon as canals and, later, railways were built, the State had as great prosperity as any section of the Union.

The early farm was an economic unit. The chief object was to supply the farmer and his family with food and clothing. The production of a surplus for sale came later. Wheat, corn, oats, potatoes, buckwheat, some fruits, and most of the garden vegetables were the pioneer crops. The white man naturally took over the culture of maize. Fodder was not at first used as its value was not appreciated and the cattle were allowed to browse in the ample wood pastures. The husking of the corn, as with so many features of early life, called for a "bee" and had a social effect which is lost to the modern farmer. Excess corn was in part made into whiskey for which there seems always to have been a sufficient local market.

In the second year of settlement wheat was planted, the first crop being grown in 1789 at Marietta. Harvesting was done with a sickle and later a cradle, and threshing with a flail or under the hoofs of horses or oxen. Rye was a more certain crop than wheat and had an early popularity with the producer and drinker. Buckwheat is always a vanguard cereal. Flax was raised and on the same farm woven to linen. Hemp for rope was an important crop in places until brought into competition with slave-grown hemp from Kentucky. Broom corn was grown for a time but has disappeared. Fruits, of course, played an early role in Ohio agriculture.

RURAL CONDITIONS TODAY

The trend of rural populations and conditions today may be made the basis of prophecy for the future, but such statements should be made with great care. The reader may draw his own conclusions from the following facts.

From the table showing the acreage of farms and improved lands comes strikingly the fact that for twenty years farming has been losing ground. The reason lies partly in the story of city growth as told in the last chapter of this bulletin. This does not mean necessarily that agricultural wealth has decreased, for in 1900 all farm property was valued at \$1,199,000,000; in 1910 at \$1,903,000,000; and in 1920 at \$3,096,000,000. The discrepancy between the decreased acreage and the increased value is due to (1) abandonment of lands unfit for agriculture, (2) improvement of farm values by absorbing small farms by larger and better organized units, (3) general increase in land values over the whole country, (4) special increase in values near the growing cities, (5) betterment of transportation, (6) an inflation of values due to the war.

Number of Farms and Farm Acreage: 1850 to 1920

Census year	Farms		Land in farms				Per cent of land area in farms	Per cent of farm land im- proved
	Number	Per cent of in- crease†	All land		Improved land			
			Acres	Per cent of in- crease†	Acres	Per cent of in- crease†		
1920---	256,695	—5.6	23,515,888	—2.4	18,542,353	—3.6	90.2	78.9
1910---	272,045	—1.7	24,105,708	—1.6	19,227,969	—0.1	92.5	79.8
1900---	276,719	10.1	24,501,985	4.9	19,244,472	4.9	94.0	78.5
1890---	251,430	1.7	23,352,408	—4.8	18,338,824	1.4	89.6	78.5
1880---	247,189	26.1	24,529,226	13.0	18,081,091	25.0	94.1	73.7
1870---	195,953	8.9	21,712,420	6.1	14,469,133	14.6	83.3	66.6
1860---	179,889	25.1	20,472,141	13.7	12,625,394	28.2	78.5	61.7
1850---	143,807	-----	17,997,493	-----	9,851,493	-----	69.0	54.7

†A minus sign (—) denotes decrease.

There were in Ohio in 1920 some 256,695 farmers of whom 94 per cent were native born whites, less than 1 per cent were negro, and the remainder were foreign born. Of these operatives 9,096 were women. In 1920 there were 1,616 negro farmers in the State. They owned 100,412 acres of land of which 76,437 acres were improved. The value of the lands and buildings was \$9,126,482 and contrasted with the white farmers, the negroes had improved 76 per cent of their land while the white men had improved 92 per cent. The average value of land and buildings per acre was \$91.00 for the blacks and \$132.00 for the whites. As the negroes are naturally social and have little capital they tend to live in

the cities. In 1910, Montgomery County had a negro population of 5,481 of whom 4,842 lived in Dayton. Butler County in the same year had 1,781 negroes of whom 1,430 lived in Hamilton, Middletown, and Oxford.

The agricultural wealth of the southeast portion is decidedly below normal for the State. The farms of that territory have a relatively small acreage of cultivated land and the fertility is less than that of the cultivated land of the rest of the State. In the hill country many farms are of the primitive sort. The house and barn may be of logs situated near a spring where a small patch of bottom land or steep hillside is farmed with slight success. This is not a true picture of the *average* farm of that section but taken on the whole the farms of the hill country are decidedly inferior to those of the remainder of the State. This condition is a contrast with the south half of Butler County on the glacial plains where a survey shows that in 1913 practically every house had all the modern household conveniences and many had a bath, kitchen plumbing, furnace, and lighting system. Such could not be said of any equal area in the hill country.

Within the hill counties, however, there are decided contrasts. Where valleys are broad, as along the Scioto or Muskingum, or where hilltops are extensive and fertile, as in Columbiana County, there is a strong economic distinction between the farmers of the flat land and of the slopes. In the south half of the river counties, Adams, Scioto, Lawrence, Gallia, Meigs, and Athens, the distinction between the rich farmers and the poor farmers is not only economic but decidedly social. The contrast is the stronger because one would expect to find in the open country the home of democratic ideals. The differentiation is best seen in the center of rural social organization, the country church. The people in these counties who support the churches are those living on farms of 100 to 150 acres. Those on small farms where crop growing is difficult have barely enough to feed and clothe themselves, and have little for church support. Hence they do not attend the churches of the rich farmers but form temporary organizations which in many cases are poorly administered by emotional preachers who do not hold their congregations.

In Monroe, Belmont, Jefferson, Carroll, and Columbiana counties the countryside does not have the bottom lands, with the exception of the Ohio Valley, and the streams are encased in deep, steep-sided valleys. Between the hilltops and the brink of the valleys are broad, fertile shelves, occupying, in Columbiana County, one-third of the territory. It is here that the better farming communities exist. In the valleys are farms on which a little patch of flood plain or steep slope is cultivated. Not only is there the difference in wealth of the two types but the 300-foot wall of the valley stands as a definite barrier against intercourse. In Coshocton, Muskingum, and Morgan counties the better

farms are either on the flat hilltops or on the valley bottoms of the Muskingum and its tributaries and the poorer society is on the steeper slopes. In Hocking County about the little town of South Bloomingville there are distinct groups of small farmers in the valleys and on the hilltops, the difference in elevation being 300 feet. Separate and parallel roads serve the valleys and the ridge lands. Each community may have its own store, school, and church. Vinton County is all slope, which condition isolates groups from each other but does not create class distinctions. Where the glacial plain abuts the escarpment of the plateau, as in Fairfield County, there is a still more decided contrast in the two societies.

The social disorganization of the southeast may be estimated by the number and kind of churches. In Adams County one township of 36 square miles and 976 people had 7 churches in 1913, while another of 40 square miles and 1,332 people had but one church and one other preaching place, the difference being in part a matter of ease of communication and of wealth of the farmers.

Schools and school buildings are a measure of community prosperity. Of 548 schools in five counties in the southeast 526 were frame, 18 of brick, 2 of concrete, and 2 of logs. Of these, 86 per cent drew drinking water from wells, 15 per cent from cisterns, 7 per cent from springs, and 2 per cent from creeks. Of 90 schools surveyed in Butler County at the same time, 86 were of brick, and the other 4 frame.

In considering comparative conditions of rural economy in the two regions it should be remembered that it costs a farmer more per acre to prepare a seed bed or plant seed for poor hilly land than for the rich level plains. It is as much trouble, or more, to plant and till for a poor crop as for a good one. Either there is the same investment for machinery or the hill farmer puts in more labor. If a farmer devotes 12 bushels of wheat to pay the cost of cultivating and harvesting an acre then the margin is his profit and the margin for many farmers in the southeast is critically low.

In 1900 the farmers of the unglaciated portion cultivated 24.2 per cent of the farm land of the State and yet expended but 12 per cent of the total for labor. The hill farmer frequently is too poor to hire help, which means that the farm is not kept up properly or that the entire family works or both. Detrimental conditions which are social, educational, and sanitary are a natural consequence.

A great deal has been said about the more unfortunate quarter of the State. The remainder is better known as it is famous for its rich lands, its general prosperity, and its excellence of living conditions. Throughout the region of the glacial plains metaled highways and electric and steam railways bring modern improvements to the very door of the farmer and he in turn is able to send his products east, west, north, or south to the best markets. Such prosperous scenes as are

found along the National Highway between Columbus and Newark, on the rich lands about Fostoria, or about Greenville tell eloquently the happy combination of well-directed human industry, rich, level land, favorable climate, and ease of transportation to ready markets.

Bibliography on Agriculture

For the greater part of the chapter on Agriculture I am indebted directly to "The Agriculture of Ohio" by Lloyd, Falconer, and Thorne (Ohio Agr. Exper. Sta. Bull. 326, 1918) which to date supersedes all other agricultural histories of the State and which will be an authority for a long time. A supplement is now being prepared to bring the statistics up to include the 1920 census. Various members of the Department of Agriculture of the Ohio State University have rendered assistance, especially Mr. G. W. Conrey and Mr. J. I. Falconer. Various masters' theses in agriculture at Ohio State University were of great value among which were: "History of Agricultural Land Values" by F. L. Morrison (1917), "The Effect of Land Tenure on the Social and Economic Conditions of Agriculture in Southeastern Ohio" by E. S. Poston (1905), "A Study of Farm Practices" by W. E. Palmer and J. C. White (1905). "A Graphic Summary of North American Agriculture" by Finch and Baker (U. S. Dept. of Agr., 1917) and "The Centers of Agricultural Production" by L. H. Goddard (Ohio Agr. Exper. Sta. Circular 100, 1910) give maps of plant distribution. The most recent census of the Government gives the latest data. There are two articles on the role of glaciation, "Influences of Glaciation in Ohio" by W. H. Haas (Bull. Phila. Geog. Soc., Vol. XV, 1917, pp. 19-42) and "The Influence of Glaciation on Agriculture in Ohio" by E. W. Owen (Bull. Scientific Laboratories of Denison University, Vol. VII, 1912-14, pp. 390-394). For conditions of rural life in Ohio consult "Rural Population in Ohio" by L. H. Goddard (Ohio Agr. Exper. Sta. Circular 116, 1911), the "Atlas of American Agriculture" (U. S. Dept. of Agr., 1919, Part IX, Section 1), and the several publications of the Board of Missions of the Presbyterian Church on rural conditions in the State.

CHAPTER IV

MINERAL RESOURCES

INTRODUCTION

Ohio is and will continue to be one of the important mineral states of the Union. In 1919 the State ranked fourth in value of mineral products. Clay is its greatest resource though today the value of coal produced annually is the greater of the two. The coal is exhaustible but the valuable clays associated with the coal are practically unlimited. In order of importance in 1920 the principal mineral resources were coal, clay products, stone, sand and gravel, gas, and oil. Other resources were limestone for industrial, structural, and agricultural purposes; sandstone for structural and abrasive uses; salts of several sorts; and waters for domestic and industrial purposes. Ohio stood first in value of clay products; second in value of sand and gravel and stone; third in value of bromine, calcium chloride salt, and abrasives; fourth in value of bituminous coal, common salt, gypsum, and natural gas. It was tenth in value of petroleum produced.

To appreciate the distribution of mineral resources and the problem attendant upon their development, one must be informed as to the distribution of the outcrops of the rocks of the State and their geologic succession. The distribution of the rocks is shown on the geologic map (Fig. 20, p. 63) and their succession is given, oldest at the bottom, in the column on page 62. To correlate the facts of the map and the column one should remember that from Cincinnati to near the west end of Lake Erie there runs an axis of a fold and that from this axis the rocks dip gently to the southeast on one side and to the northwest on the other. Not all rocks are continuous across the State; they may thin and disappear and also may be inconstant in their economic nature. Much more is known of the rocks of the southeast as there is no covering of glacial drift in that section to obscure the facts.

Geologic Column

<i>System</i>	<i>Series or formation</i>	<i>Common rock</i>	<i>Principal economic products</i>
Quaternary	Recent-----	Soil, clay, peat, sand, gravel, marl-----	Brick, tile, sand and gravel, molding sand, cement
Permian---	Dunkard-----	Shale, sandstone, coal----	Grindstones, pulp wheels, brick
Pennsylvanian	Monongahela----	Coal, shale, sandstone----	Coal
	Conemaugh-----	Shale, sandstone, limestone, coal-----	Coal, brick, oil
	Allegheny-----	Coal, clay, shale, sandstone, limestone-----	Coal, pottery, sewer pipe, brick, cement
	Pottsville-----	Coal, clay, shale, sandstone, conglomerate, limestone-----	Coal, brick, sewer pipe, salt, molding sand, oil
Mississippian	Maxville-----	Limestone-----	Lime, cement
	Waverly-----	Shale, sandstone-----	Oil, gas, brick, building stone, grindstones
Devonian	Ohio-----	Shale-----	Brick
	Olentangy-----	Shale-----	Fire proofing, tiling
	Delaware-----	Limestone-----	Ballast, road metal, building stone
	Columbus-----	Limestone-----	Flux, ballast, road metal, lime, building stone
	Monroe-----	Limestone-----	Road metal, lime, gypsum
Silurian	Salina (not at surface)-----	Limestone, rock salt-----	Salt
	Niagara-----	Limestone-----	Ballast, road metal, lime, flux
	Brassfield (Clinton)-----	Limestone-----	Road metal, flux
	Medina (not at surface)-----	Sandstone, shale-----	Gas, oil
Ordovician	Richmond-----	Shale, limestone-----	Road metal, building stone
	Maysville-----	Shale, limestone-----	Road metal, building stone
	Eden-----	Shale-----	
	Trenton-----	Limestone-----	Oil, gas

PEAT

Peat is coal in the making. That is to say, it is partially decayed vegetation which has been preserved in stagnant waters in which it accumulated. There are all gradations from peat which retains the fibrous structure of the vegetation from which it was derived to peat which is disintegrating into soil. Peat in Ohio was formed in the lakes and swamps which succeeded the glacier. Where there were bodies of water of some permanence which were not too deep, too agitated, or did not receive too much sediment, there vegetation was free to accumulate. After the partial decay of these plants by bacteria and fungi the vegetable material was preserved in quantity beneath the water and beneath successive layers of mold till now they form one of the large, though little appreciated, resources of Ohio.

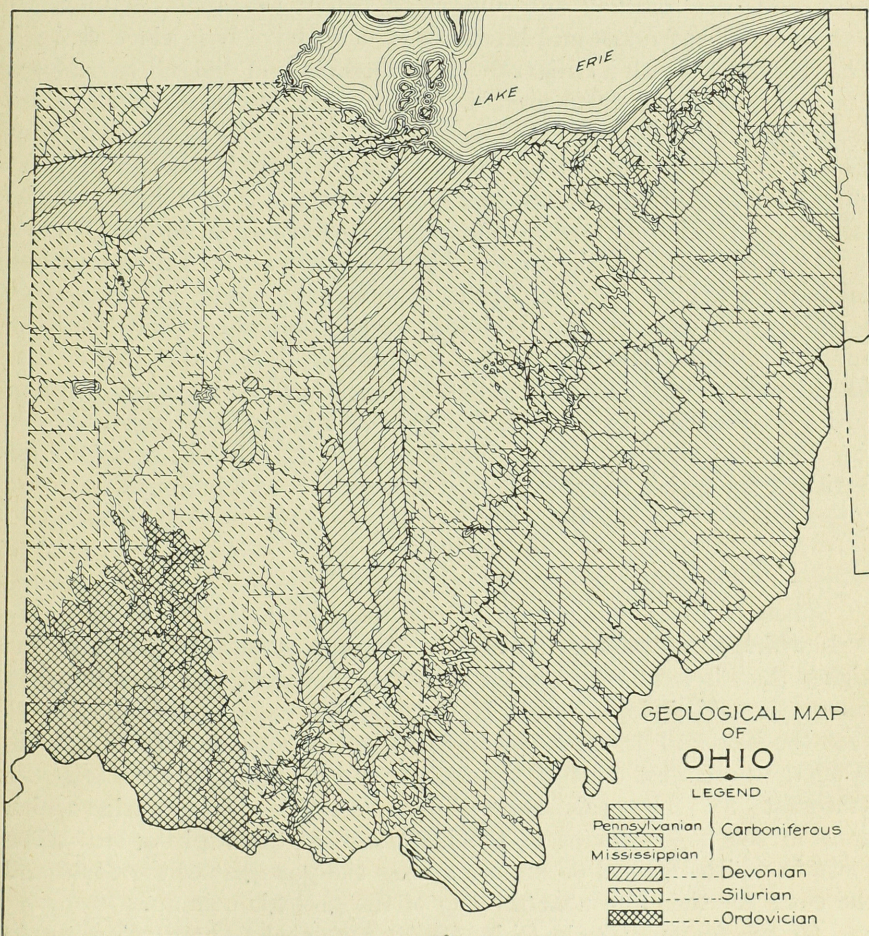


Fig. 20—Geological Map of Ohio

The topographic conditions favorable for peat growth are found in this State within the glacial margin exclusively. The level plains, with shallow depressions, low divides, old lake bottoms, and sluggish streams were ideal for its development; much more so than the lake plains which, over much of their area, had too great a depth of water for peat formation. On this account the "black swamp" region lacks the bogs of the uplands, but the lagoons and sheltered bays of the retreating predecessors of Lake Erie were the sites of some peat bogs.

In 1912, an area totaling 155,047 acres had been ascertained by the Government to have peat averaging 10 feet in thickness. This was probably but 85 per cent of the correct total. Much of this was of good quality for fuel and other purposes. The bogs form one of the large resources for the near future. There are, however, many peat and semi-peat lands of immediate value for agriculture. Hundreds of acres had been drained and cultivated before the above estimate of acreage had been made and hundreds of acres have been since drained. The rich humus with its mineral content forms a soil difficult to exhaust.

Though peat is little used in Ohio today, its uses elsewhere are prophetic for the future. Peat is not only consumed in the time-honored blocks in Germany and Ireland for fuel but is burned in great quantities in powdered form and in briquettes. It is a basis for the manufacture of industrial coke, illuminating and fuel gas, and, in Canada, for the producer-gas engine. Other industrial uses are for tar, ammonium sulphate, ethyl alcohol, dye stuffs, tannic acid, paper (as at Capac, Michigan), woven fabrics, building board, mattresses, and sanitary appliances. This last use was of importance during the World War when its absorbent, deodorizing, and antiseptic properties put a premium on its production. In this country it is used in normal times as stable litter and for packing. Its one industrial use in Ohio was as a filler for fertilizer, for which purpose there was a factory at Plymouth.

COAL

There lie immediately west of the Piedmont belt thick sedimentary beds which were washed down from the belt at a time when it was higher than it is now and when a shallow sea stretched over the area where the Mississippi Valley is today. The sediments are thickest near the belt and are now bowed so as to form a great trough. Ohio is on the northwest edge of the trough and so the beds have a gentle southeast dip. The coals are the hardened residue of vegetation which grew in the peat swamps in the last stage of the expiring sea. The rocks in which the coal occurs are among the youngest of the State and the coals are therefore near the top of the geologic column.

Of the 88 counties in Ohio, 29 produce coal. There are some 40 coal beds and, as they represent ancient swamps, most of them are not

continuous over any great area. Twelve of these beds are regularly mined for railroad shipment; their names, numbers, and relative positions are shown in the following section:

Principal coal beds of Ohio

Monongahela formation	{	<i>Meigs Creek</i> (No. 9) coal
		Shales, sandstone, and limestone, 55 ft.
		<i>Pomeroy</i> (No. 8a) coal
		Shales, sandstone, limestone, and clay, 25 ft.
Conemaugh formation	{	<i>Pittsburgh</i> (No. 8) coal
		Shales, sandstones, limestones, and thin coal beds, 350 ft.
		<i>Mahoning</i> coal
		Shale and sandstone, 50 ft.
Allegheny formation	{	<i>Upper Freeport</i> (No. 7) coal
		Shales, sandstone, and clay, 43 ft.
		<i>Lower Freeport</i> (No. 6a) coal
		Shales, sandstone, clay, and limestone, 45 ft.
		<i>Middle Kittanning</i> (No. 6) coal
		Shales, sandstone, limestone, and clay, 23 ft.
		<i>Lower Kittanning</i> (No. 5) coal
		Limestone, shale, clay, and iron ore, 18 ft.
		<i>Clarion</i> (No. 4a) coal
		Shales, sandstone, clay, and limestone, 30 ft.
Pottsville formation	{	<i>Brookville</i> (No. 4) coal
		Shale, sandstone, clay, and limestone, 45 ft.
		<i>Bedford</i> coal
		Shales, sandstone, limestone, flint, and thin coal beds, 123 ft.
		<i>Quakertown</i> (No. 2) coal
		Sandstone, 85 ft.
	{	<i>Sharon</i> (No. 1) coal

Three of these beds, because of their thickness, persistence, and quality, are famous. They are, oldest and lowest first, the Middle Kittanning or No. 6, the Upper Freeport or No. 7, and the Pittsburgh or No. 8. (Fig. 21, p. 66)

Middle Kittanning coal.—The Middle Kittanning coal is the most persistent of the three. It is of workable thickness in every county where it appears as an outcrop and it extends across the State diagonally from Columbiana County to Lawrence. It forms the principal bed of the Hocking Valley field, which lies in Perry, Hocking, and Athens counties, where (according to Orton) the coal is 5 feet or more in thickness, the maximum being 15 feet. The field still has much coal but its thickest parts are a thing of the past. Other important deposits of this coal bed are found in Muskingum, Coshocton, Tuscarawas, and Carroll counties. The coal is strong and hence is sold with an unusually large proportion of lumps; its heating value is high, but unfor-

tunately it produces much smoke and cinders. It has been called the great steam coal of Ohio.

Coal production of Perry, Hocking, and Athens counties

	<i>Short tons</i>		<i>Short tons</i>
1883-----	3,439,873	1914-----	5,716,203
1890-----	4,446,299	1915-----	4,921,493
1900-----	7,166,916	1918-----	11,829,924
1913-----	8,824,820	1921-----	6,290,477

Upper Freeport coal.—The Upper Freeport is the least important of the three great coal horizons. Its distribution is similar to that of the Middle Kittanning but it lacks the remarkable persistence of that

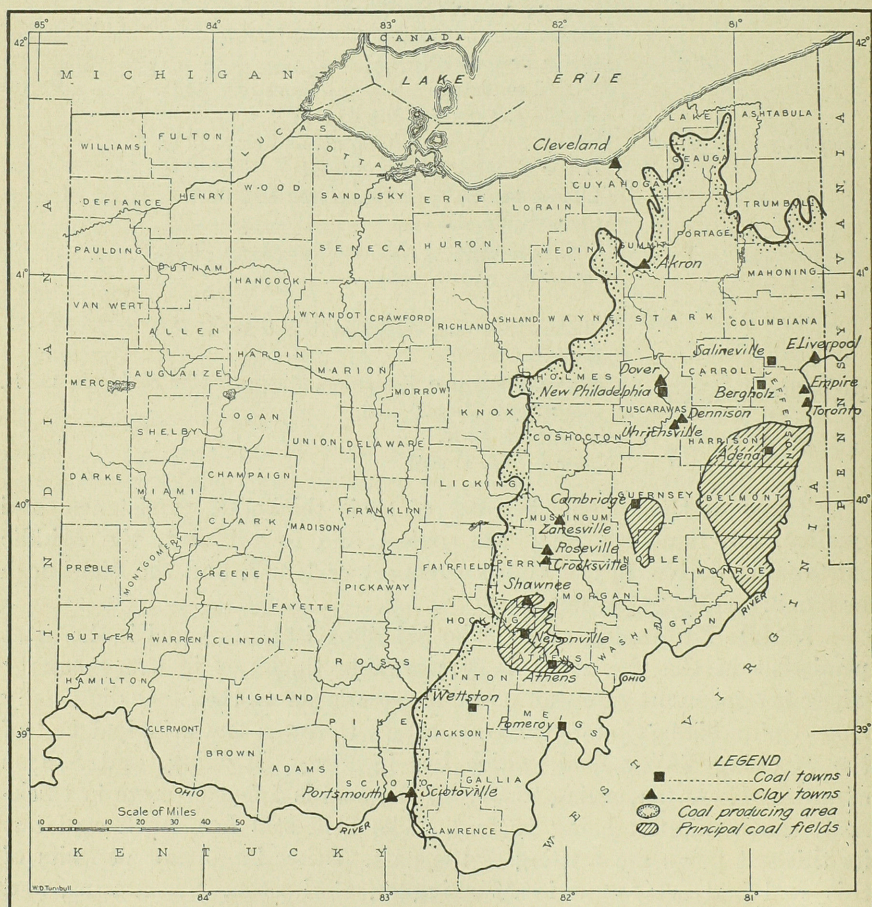


Fig. 21—Coal Fields, Coal Towns, and Clay Towns. The area east of the heavy line is underlain by coal beds but the most important producing areas are the three shown by shading.

bed. Only in limited places is it well developed and there are extensive areas where it is too thin for working. Also the coal does not bear transportation well as it breaks easily and is affected by weathering. The presence of this bed in the south half of Guernsey County makes that county one of the greatest producers in the State. This area with part of Noble County is known as the Cambridge field and near the city of that name the bed is about 6 feet thick. The field was producing on a large scale as early at least as 1880 and has now passed its zenith. Columbiana County contains much of this coal and it has long been worked at Salineville where the bed is 7 feet in thickness. In a smaller way this coal is mined in several other counties.

Coal production of the Cambridge field, Guernsey and Noble counties

	<i>Short tons</i>		<i>Short tons</i>
1883.....	244,650	1913.....	5,109,133
1890.....	420,539	1918.....	5,285,001
1900.....	1,941,373	1921.....	3,521,126

Pittsburgh coal.—The Pittsburgh coal occurs in three principal localities: the Belmont County field, the Federal Creek field of Morgan and Athens counties, and the Swan Creek field of Gallia County. Though the coal extends over a greater area, elsewhere it is thin and under present conditions useless.

The Belmont County field is by far the largest and most important of the three mentioned. It includes nearly all of Belmont and parts of Jefferson, Harrison, Guernsey, Noble, and Monroe counties. The Ohio River cuts through the coal as far as the southeast corner of Belmont County where the coal forms the bed of the stream. Besides the Pittsburgh coal there are two other workable beds, the Meigs Creek and Uniontown, which make Belmont the most important coal county. The Pittsburgh bed in this county is, where worked, usually from 4 to 5 feet in thickness and remarkably uniform. It was mined as early as 1825 and has been shipped by river since 1835, some of it going as far as New Orleans. The Baltimore and Ohio Railroad began hauling coal from the vicinity of Bellaire in 1858.

Coal production of Belmont County

	<i>Short tons</i>		<i>Short tons</i>
1890.....	774,110	1913.....	10,436,259
1895.....	846,643	1914.....	2,849,181
1900.....	1,345,284	1915.....	4,304,566
1905.....	3,957,980	1918.....	11,852,508
1910.....	8,265,019	1921.....	11,601,150

In the case of both the Federal Creek and Swan Creek fields the coal is of poorer quality and is in a country without good shipping facilities.

The Pittsburgh coal of Ohio does not rival in quality that of Pennsylvania where the bed is at its best. It is a little high in sulphur and largely on that account it is not used for coke. The coal has been called the great gas coal of Ohio.

Coal mined in Ohio

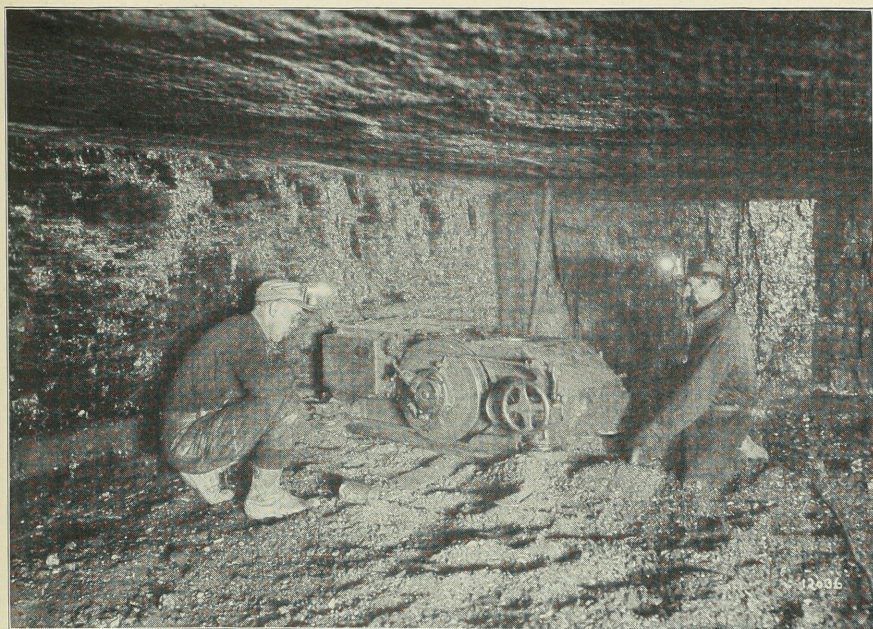
	<i>Short tons</i>		<i>Short tons</i>
1838-----	119,952	1900-----	18,988,150
1850-----	640,000	1913-----	36,200,527
1860-----	1,265,600	1914-----	18,843,115
1870-----	2,527,285	1915-----	22,434,691
1880-----	6,008,595	1918-----	45,812,943
1890-----	11,494,506	1921-----	33,054,103

The decided drop in 1914 was due in part to a poor market but mainly to labor troubles which tied up practically all the mines from April to July and, in the Cambridge field, till August. The average number of working days per miner was half what it was in 1913 and 6,452,762 days were lost by 40,577 men. The large production of 1918 was due to the war. That year there were 48,450 men employed of whom 39,883 worked underground. In spite of the fact that it was a war year, strikes lost 44,837 days to the Government.

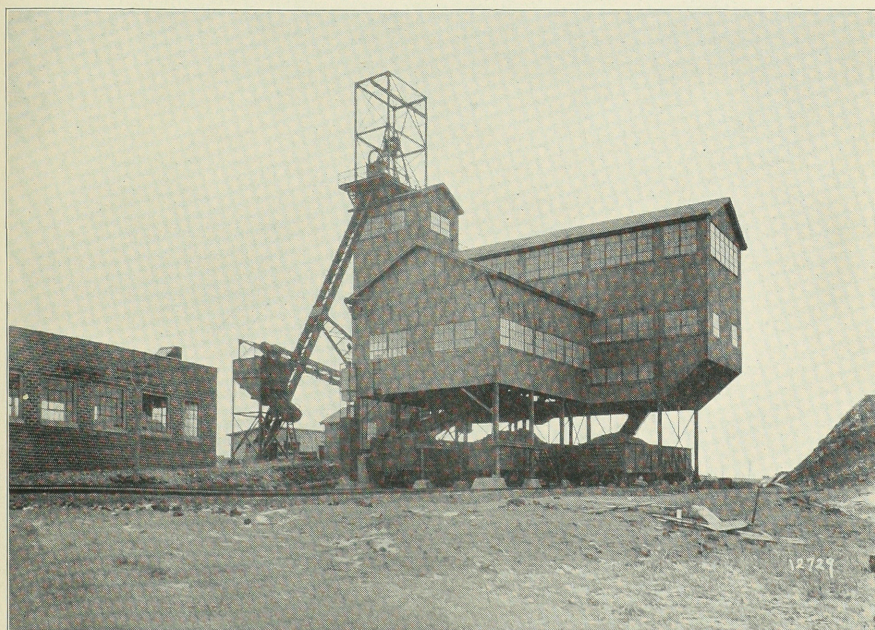
Physiographic processes have influenced the recovery of Ohio coals. The beds occur mainly in the unglaciated plateau country. The strike or line of outcrop of the coal is in a northeast-southwest direction. Much of the drainage is approximately at right angles to the strike, hence the outcrop of the coal is not only found on both sides of the main valleys but it runs in and out of minor tributaries with all the intricacy of a contour line on the hillsides. Also the valley walls are so steep that the coal is actually exposed to view in many places. In spite of the advantages of such conditions it must be remembered that the valleys represent a huge area of coal beds which have been wasted away by stream erosion and forever lost to mankind.

Coal was thus easily discovered and has required but little prospecting. As the bedrock has few faults or dislocations and an average dip of 25 to 40 feet to the mile, the driving of nearly horizontal drifts has made coal mining a task which required little skill and no great capital, when operations were on a small scale. This accounts for the extraordinary number of mines compared to the total output of coal. Shafts are used, of course, and though costing more in the first place, have the advantage of placing operations in the center of a coal area rather than at the edge. So far as is known, the first Ohio shaft was sunk at Steubenville in 1853. The deepest shaft at present, 412 feet, is in Athens County.

The innumerable valleys offer excellent drainage for they not only lower the water table but a tunnel may be run from the mine to the



A—Miners at work in Belmont County. The machine undercuts the coal after which it is blasted down and loaded into mine cars. (Courtesy the Jeffery Mfg. Co.)



B—A coal tippie in Belmont County. The coal is raised from the mine and after screening loaded directly into the cars. (Courtesy the Jeffery Mfg. Co.)

valley wall and so permit the mine to drain itself. The Ohio fields are not without their water problems, however, especially in the Mahoning Valley where the rock is much jointed so that underground flow is easy.

Another result of the hilly character of the region is that it naturally was not so completely cleared of timber as was the plain, and much of the timber used in the mines as props has been obtained in the vicinity of the pit mouth.

The almost horizontal nature of the rock combined with the moderate relief of the region has made stripping projects profitable. The surface of the hill is stripped with a steam shovel and coal laid bare for open air mining. Even on the hillsides stripping may be carried on until the cost becomes too great and drift mining is resorted to. This is a recent development and a small percentage of the coal is produced in this manner today. The mature dissection due to stream erosion has forced the railways to build in the valley bottoms. Thus a mine on a hillside may haul the coal out on a downgrade to the tipple from where it is loaded directly into the railway cars. This is a very common situation and may be seen repeatedly as the Hocking Valley Railway winds its course through Vinton County.

The range of composition of Ohio coals is not great. All are bituminous and all are steam coals. Today no coals from the State, except a very small quantity from the Steubenville bed, are used for coking though certain members have from time to time been made into coke, which however could not compete with the standard from Connellsville, Pennsylvania. The Lower and Middle Kittanning, the Lower and Upper Freeport, and Pittsburgh coals have been used for this purpose. The Pittsburgh has been the most extensively coked, having been used at various times in 180 ovens. The use of Ohio coals for gas has been hindered by two things, the discovery of natural gas and the fact that Ohio coals do not coke well. They give a low yield of gas and a coke residue of poor quality. Though all of the coals are used for steam making, the Pittsburgh, Middle Kittanning, and Upper Freeport are the favorites.

IRON ORE

Ohio contains deposits of iron ore which are associated with the coal strata but the beds are very thin and relatively lean. Consequently these deposits cannot compete with the ores of Lake Superior and Alabama. The Ohio ores were used as early as 1804 in making pig iron and that industry reached its climax about the time of the Civil War, after which the competition offered by the Lake Superior ores became prohibitive to local mining and the furnaces one by one closed. Today the furnaces and their associated villages are desolate wrecks, the ghosts of a former industry. The last of these furnaces was Jeffer-

son, near Oak Hill, Jackson County, which, using charcoal for fuel from the surrounding timber lands, operated almost continuously from 1854 until finally closed in 1918. Evidence of the existence of these furnaces is seen in the names of hamlets, such as Scioto Furnace, Union Furnace, and Lawrence Furnace. Through these old furnaces and forges the great blast furnaces and steel mills of today were gradually evolved.

OIL AND GAS

Oil and gas are residues of plant and animal material which lived in the seas of geologic antiquity. Under pressure and local disturbance of the rocks this material may move about underground, tending to accumulate in certain favorable places. As the decayed matter is lighter than sea water occluded in the rocks, it naturally rises and the gas which is the first stage of decay of organic matter will rise yet higher. Any porous rock such as a sandstone or a limestone will act as a reservoir when there is a capping of some impervious rock, such as shale. The latter prevents the escape of oil and gas as it is forced upward by the water pressure. When this capping is domed, accumulations of oil and gas may occur. Thus it is that gas, oil, and salt water are associated with each other.

The first appreciation of the oil and gas resources of the State was arrived at from drilling of salt wells. Gas pressure had erupted salt water and oil from a well drilled near the village of South Olive, Noble County, in 1814 and continued "blowing" for 24 years. In Washington County at the same date petroleum was obtained and sold as "Seneca Oil" for medical purposes and was also used for illuminating and lubricating. But the oil in salt wells spoiled the brine and the gas was considered dangerous, so that it was not until 1859 with the sinking of the Drake well in Pennsylvania that the petroleum and gas industry began.

Oil and gas have been derived from three localities in the State, in each case the source being in a different geologic formation. The farther west the field, because of the geologic structure, the older the formation. In the Lima field of northwest Ohio, the oil and gas occur in the Trenton (Ordovician) rocks. The central Ohio field draws upon the "Clinton" beds of Silurian age. The eastern Ohio fields have drawn on a number of "sands" from the Mississippian and Pennsylvanian formations. (Fig. 22, p. 72)

Oil.—The first oil well of importance in the Trenton limestone was drilled at Findlay in 1885. The oil was dark and smelled strongly of sulphur compounds, and was therefore unpopular with both producer and refiner. Owing to these properties, refining methods of the day were not applicable but its production was so great that proper methods were soon developed. Many of the wells were large and one produced 10,000 barrels a day by actual measurement. In Allen County, near Lima, a

well after giving 60,000 barrels in six months, still made 150 barrels a day. In 1896 the Trenton field of the northwest reached its maximum production with 23,941,169 barrels a year. Since then it has steadily declined and in 1918 produced but 2,343,164 barrels. It is not likely to give much oil again though it may remain a small producer for many years. More than 30,000 wells have been sunk in that part of Ohio and the extent of this undertaking may be estimated from the following condensed well record, representative for the field:

General well record for Lima field

	<i>Thickness of beds</i>	<i>Total depth of well</i>
Drift.....	8 feet	8 feet
Bedrock	1,084	1,092
Trenton limestone at.....		1,092
"Pay rock" at.....		1,142

The depth of these wells varies with the topography and with the structure. The dome in which this oil occurs is the northward extension of the Cincinnati axis which was referred to in the first chapter. Naturally, wells on the summit of this axis are shallowest.

The second field lies near central Ohio and runs from Wayne County south into Vinton. Originally the production in this region was gas, but in 1899, twelve years after the gas discovery, oil was "brought in." The field assumed importance only as late as 1907. The oil as well as the gas comes from the "Clinton" formation of the Silurian period. A characteristic well record follows:

Generalized well record for central Ohio field

	<i>Thickness of beds</i>	<i>Total depth of well</i>
Mantle rock.....	49 feet	49 feet
Bedrock	2,534	2,585
"Clinton" sand (oil).....	34	2,619
Bottom of well.....		2,620

The oil resembles the light oils of Pennsylvania and West Virginia. The sand is free from water and thus the reservoirs may be in shallow depressions rather than in domes as in most fields, as there is not the hydrostatic pressure to force the oil upward. The great depth of the sand makes the cost of drilling heavy and as the sand plays out unexpectedly many wells never find it.

The fields of eastern Ohio have obtained oil from sandstones of both Mississippian and Pennsylvanian age. There are five principal producing sands but these have nothing like the continuity of the "pay rock" in the other two fields just described. The sands vary in depth, in thickness, and in productivity, and they may play out with little warning. A composite well record from Washington County gives the average thicknesses and relations of the sands:

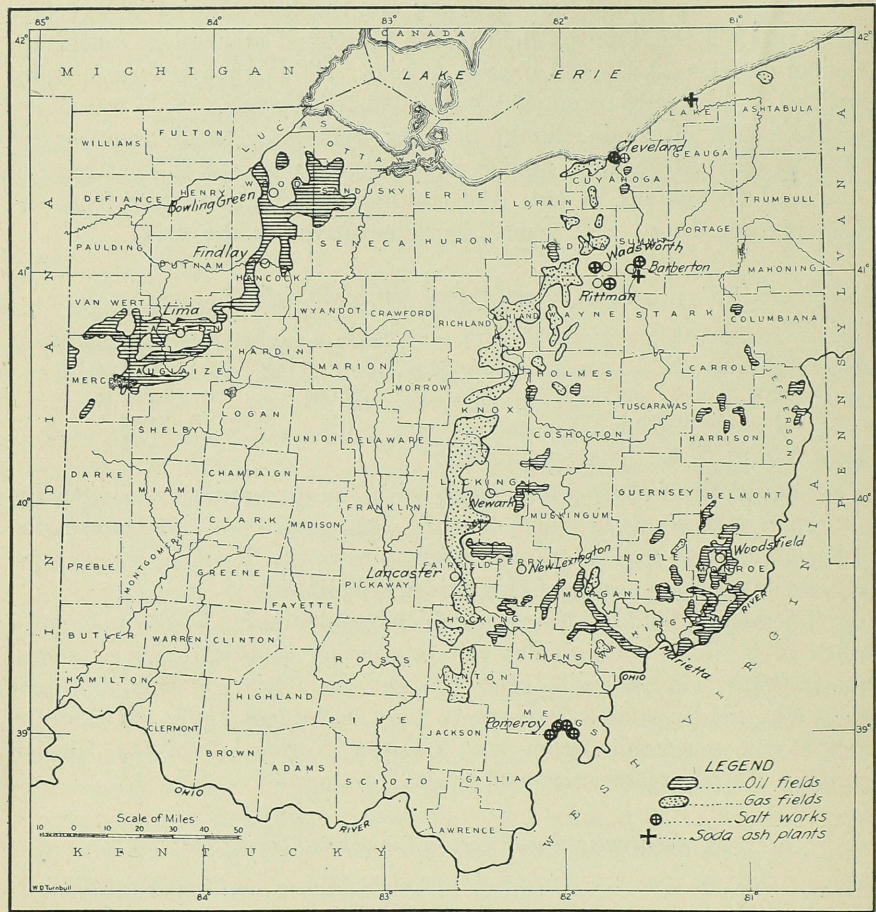


Fig. 22—Oil, Gas, and Salt

Generalized well record for southeastern Ohio

		Thickness of beds	Total depth of well
Recent	Mantle rock	10 feet	10 feet
Pennsylvanian	Bedrock	333	343
	Macksburg 140-foot or First Cow Run sand (oil)	35	378
	Bedrock	307	685
	Macksburg 500-foot sand (oil)	17	702
	Bedrock	414	1,116
Mississippian	Bedrock	5	1,121
	Keener sand (oil)	55	1,176
	Bedrock	15	1,191
	Big Inju n sand (oil)	115	1,306
	Bedrock	394	1,700
	Berea sand (oil)	14	1,714

The irregularity of the beds is well illustrated by the Macksburg 500-foot sand (so called because it is 500 feet below the surface of Duck Creek at Macksburg), which is not persistent over the country but in places is the source of important wells. The Macksburg 140-foot or First Cow Run sand is important only in Morgan, Noble, and Washington counties. The wells, therefore, vary in depth with topography and structure, and the oil sand is drawn upon from 12 to 2,200 feet below the surface. Usually shallow wells are long lived and one near Joy, Morgan County, which is only 98 feet deep, has been yielding since 1872 and still pumps 3 barrels a day. Generally speaking, the wells of eastern Ohio have not been great producers and 500 barrels a day initial production is considered an excellent record.

Every county of the State has been drilled to a greater or less extent. It is improbable, therefore, that any large pools will be discovered. The rise and decline of oil production in the State is shown by the following table:

Oil production of Ohio

	<i>Barrels</i>		<i>Barrels</i>
Previous to 1876.....	200,000	1895.....	19,545,233
1876.....	31,763	1896.....	23,941,169
1877.....	29,888	1898.....	18,738,708
1880.....	38,940	1904.....	18,876,631
1884.....	90,081	1907.....	12,207,448
1885.....	661,580	1910.....	9,916,370
1886.....	1,782,970	1914.....	8,536,352
1887.....	5,022,632	1918.....	7,285,005
1888.....	10,010,868	1919.....	7,669,000
1891.....	17,740,301	1921.....	7,330,000

That oil in Ohio has been of tremendous importance no one can deny. It has furnished wealth directly and has created a large trade in drilling materials and in domestic supplies. By virtue of royalties, lease money on lands with hope of oil, and by employment at good wages of large numbers of men and teams, it has given to the hill farmer much needed assistance. It is said that at one time the outlines of some oil pools could be traced by the distribution of freshly painted houses. Also every village profited by the trade brought to the hotel keeper and the liveryman, the grocer, and the gardener, and not least, to the lawyer.

Gas.—Natural gas was discovered in Ohio at an early date. In three places at least, Washington, Knox, and Hancock counties, the gas actually escaped through cracks in the rocks to the surface. As recounted above, gas had been discovered through drilling of salt wells. Knox County has the distinction of being the first region in which wells were drilled for gas. A small reservoir was tapped and the gas burned for the manufacture of lamp black. The great gas fields were two in number.

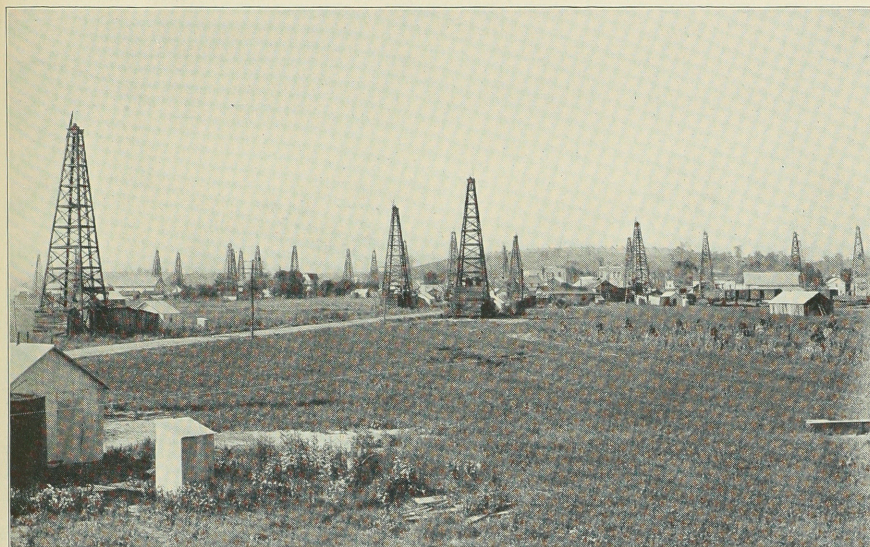
The northwest field attracted early attention because the gas act-

ually escaped from the surface in places. Nothing was done to develop the reservoir until 1884 when a well was drilled into the Trenton limestone near Findlay. At 1,092 feet sufficient gas was discovered to throw a flame 20 to 30 feet in height. The fourth well sunk produced for a short time at the rate of 1,250,000 cubic feet a day. The thirteenth well produced at the rate of 12,000,000 cubic feet a day, and the success of the field was assured. One well produced at as high a rate as 32,000,000 cubic feet in 24 hours. Findlay grew at a rapid rate and fuel was wasted extravagantly. In 1887, 15,000,000 cubic feet was used every month for the prodigal lighting of the town. Tiffin, Fostoria, North Baltimore, and Bowling Green profited in like manner. It was, unfortunately, not long before the gas pressure decreased notably and in the early nineties first the larger factories depending upon the gas and then the smaller ones either moved away or turned to other fuel.

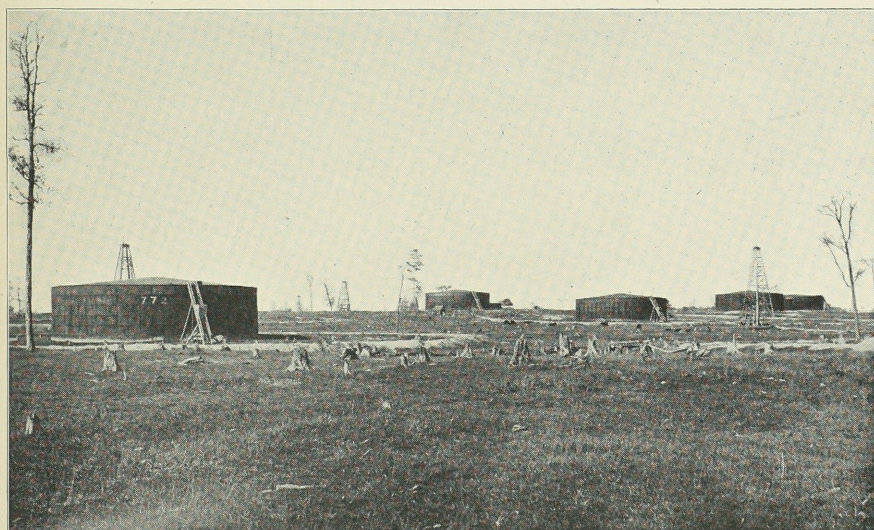
Following the example of Findlay, Lancaster experimented and successfully tapped the great supply of gas that underlay the region in 1887. The third well drilled yielded at the rate of 1,000,000 cubic feet per 24 hours. Lancaster benefited immediately. The Mithoff well, known as the "Old Man Himself," 1889, produced at the rate of 12,000,000 cubic feet in a day. The Lancaster field has been one of the most important in the State but gas was wasted here as elsewhere. An example was the illuminating of a race course with huge flares making a barbaric scene. Near the town of Newark gas was located 2,385 feet below the surface in 1887. The reservoir was small and not used for city purposes. A glass factory was established, however, on the strength of this fuel, but in a few years the factory was drawing upon the Lancaster field. North of Newark, at Homer, an area of rich gas was discovered in 1900 and it is from this field that Newark has obtained its supply. As early as 1888, the hamlet of Thurston, between Lancaster and Newark, became the site of gas operations. By 1890 pipe lines had been laid to Columbus but the supply proved inadequate before the year was passed. Today the Homer, Lancaster, and West Virginia fields are all called upon to serve that city.

The Cleveland field is really a continuation of the central Ohio field. A well was drilled in that territory in 1886 to a depth of 3,000 feet, which though proving of no value to the gas industry, made the discovery of rock salt far below the surface which led to the salt and soda ash industries of Cleveland and northeast Ohio. It was not until 1912 that gas was obtained in important quantity and then it was struck in the "Clinton" sand at 2,696 feet. In 1916 one well produced at the rate of 14,000,000 cubic feet a day. Because of the dense population of this area, a suburb of Cleveland, lease holdings were small and an abnormal number of wells were sunk. Thus the field was quickly drained.

The "Clinton" sand, though comprising an area of only about 800



A—An oil field in Fairfield County. A partial view of the oil field in and about Bremen as it looked before the derricks were dismantled. (Photo by Bownocker)



B—A tank farm in Fairfield County. In regions of oil production long lines of huge tanks are erected to store the oil from the wells. From here it is pumped to the refineries.

square miles, has in part supplied cities, towns, and villages of more than two-thirds of the State with gas from 10 to 30 years and it is not yet exhausted. It has been one of the greatest sources of natural gas of any territory or formation in the world but is inadequate to supply the demand which it has created.

As with oil, almost every county in southeastern Ohio has produced gas. Most of the reservoirs were small and though a few areas may compare favorably with equal areas of the northwestern field, taken in total they are in no way comparable to that area, and still less comparable to the "Clinton" sand fields of central Ohio. The Berea, from 1,000 to 2,000 feet below the surface, has been a large producer of both oil and gas.

Ohio is a great gas State but in 1918 it produced only 43 per cent of what it consumed. The gas imported into the State came almost entirely from West Virginia. In that same year Pennsylvania was the only other State consuming a large quantity which did not produce enough to meet its own demands. In the same year there were more consumers (889,886) in Ohio than in any other State, and the largest number of consumers (885,876) used the gas for domestic purposes. The gas thus used was 68 per cent of the total.

SALT

Eastern Ohio was blessed with salt springs and licks. (Before the coming of the white man, animals and Indians had worn paths which converged upon the favored localities, especially that in Jackson County. There is evidence that even the Mound Builders knew of and appreciated the salt. The Indians came not only for salt but to kill animals which visited the springs.) The buffalo was seen about the springs until 1802 and the Indians made their last annual pilgrimage about 1815. The buffalo trails were so well beaten that they were recognizable at least until 1837 and the last of the crude salt pans of the Indians was destroyed in 1899.

(Salt was one of the most expensive commodities of the early settler.) It was brought with great care over the Appalachian Mountains and cost \$8.00 a bushel when it arrived. This was in the day when the farmer had little or no currency. A bushel at first was counted at 80, and then 50 pounds. When the salt was weighed out no one was allowed to walk across the puncheon floor lest he disturb the scales. Hence salt making, even from the weak brines obtained at the springs, was an early and lucrative industry. (Congress soon recognized the importance of these salt springs and in 1796 took measures to prevent their monopoly.)

(Early manufacture was conducted in evaporating kettles in the open. The first genuine salt furnace was the old Scioto works on the

banks of Salt Creek, Jackson County.) Shallow wells were also sunk in those early days about Salt Creek southeast of Zanesville and about Duck Creek in Noble and Washington counties and also along the Muskingum. One well near Zanesville still has the hollow "gum" log in the hole.

The brine was weak unfortunately and deeper wells were soon put down. Drilling, which was done in a primitive manner by the spring pole method, was slow and laborious. In 1817 deeper wells were drilled in the Muskingum Valley with water power. At 850 feet a brine was discovered which made a pound of salt to a gallon of liquid. In 1833 the Muskingum Valley was producing 300,000 to 400,000 bushels of salt a year. Yellow Creek in Columbiana County, the Hocking Valley in Athens County, and Leading Creek in Meigs County were all producing salt in this early period. The industry expanded to Tuscarawas, Morgan, and Guernsey counties, but now the sites of many of the salt furnaces are forgotten.

(The city of Pomeroy in Meigs County on the Ohio River is today the site of the salt industry in southeast Ohio. Here salt making was in full swing about the end of the Civil War. It then declined under the competition of Michigan, New York, and later northeast Ohio where the brine has greater density. (Today the remaining furnaces are organized to sell their salt in the lower Ohio and Mississippi valleys availing themselves in part of cheap river transportation.) This, combined with the fact that coal underlies adjacent hills, and that bromine and calcium chloride are important by-products of the industry, permits them to sell salt in the face of severe competition.) The salt is obtained from wells which vary in depth from 300 to 1,600 feet and in general the deeper the well the greater the density of the brine. The rocks dip from the northwest and the wells are draining an area which lies in that direction.

(In the northeast of the State a younger salt industry exists which has far outstripped the southeastern. It began at Newburg, now a part of Cleveland, about 1889. Large developments have taken place in the vicinities of Cleveland and Akron, but the true extent of the salt field is much greater.) As oil and gas were discovered in wells drilled for salt, so the salt of the northeast was discovered in a well drilled for gas. At Wadsworth salt was struck between 2,400 and 2,500 feet and there is now a concern in that region operating in several beds which total 140 feet of rock salt and which are underlain by 100 feet of salt-bearing limestone. The salt is not in solution but in the solid form and hence clean water is poured down, the salt allowed to dissolve, and the resultant brine brought to the surface.

(The exact limits of the salt-producing area of northeast Ohio are unknown but the area certainly is large. At present furnaces exist in Cuyahoga, Summit, Medina, and Wayne counties.) The Salina forma-

500

tion which contains the salt and lies immediately above the Niagara is known to extend to the east, though at greater and greater depths. Near the Pennsylvania line in Trumbull County there is at 3,239 to 3,710 feet below the surface a limestone which contains 148 feet of rock salt. The westward limit of the salt lies about halfway between Cleveland and Sandusky. (Fig. 22, p. 72)

(In 1920 Ohio was behind only Michigan and New York in the production of salt though these states each produced over twice as much as Ohio.) The states producing bromine and calcium chloride were in order of importance: Michigan, Ohio, and West Virginia.

GYPSUM

Gypsum in 1920 was obtained in 19 states of which only 9 produced notable amounts. Of these Ohio, through the output of three plants, stood fourth in rank, mining 277,900 tons valued at \$2,161,000. Practically all of this was calcined, that is, the water was driven off by roasting and the rock converted to a white powder known as plaster of Paris. (The known workable deposits are in a small area about Sandusky Bay in Ottawa and Erie counties. The gypsum which is interbedded in limestone has a maximum thickness of 17 feet. Gypsum is used for making plaster, plaster board, and statuary, to retard the setting of cement, and in connection with plate glass manufacture. Sixty per cent of the gypsum supplied to plate glass companies in 1918 came from Ohio.) (Fig. 23, p. 78)

INDUSTRIAL LIMESTONE

(Limestone in Ohio is the basis for an important group of industries other than its use for building stone. In 1920 the total value produced exceeded \$9,000,000) and Pennsylvania was the only State mining greater quantities than Ohio. In reading this discussion one should refer to the geologic column at the beginning of the chapter and to the map of the distribution of limestones. (Fig. 23, p. 78)

The Ordovician limestone (Trenton) which outcrops in the valley above Cincinnati is the oldest in the State but it has little industrial use today. There are three limestones of Silurian age. The Brassfield (Clinton) makes a hot lime and is a flux rock. The Niagara limestone is a magnificent bed of great extent and thickness and it is well exposed. Most of it is dolomitic but one bed is 94 per cent calcium carbonate. It is the principal source of white lime, makes an excellent building stone, has layers adaptable for road metal, is used as flux in basic steel industries, and as a neutralizer of acid soils. The Monroe formation covering 1,000 square miles of the State furnishes a great deal of the crushed stone of the northwest.

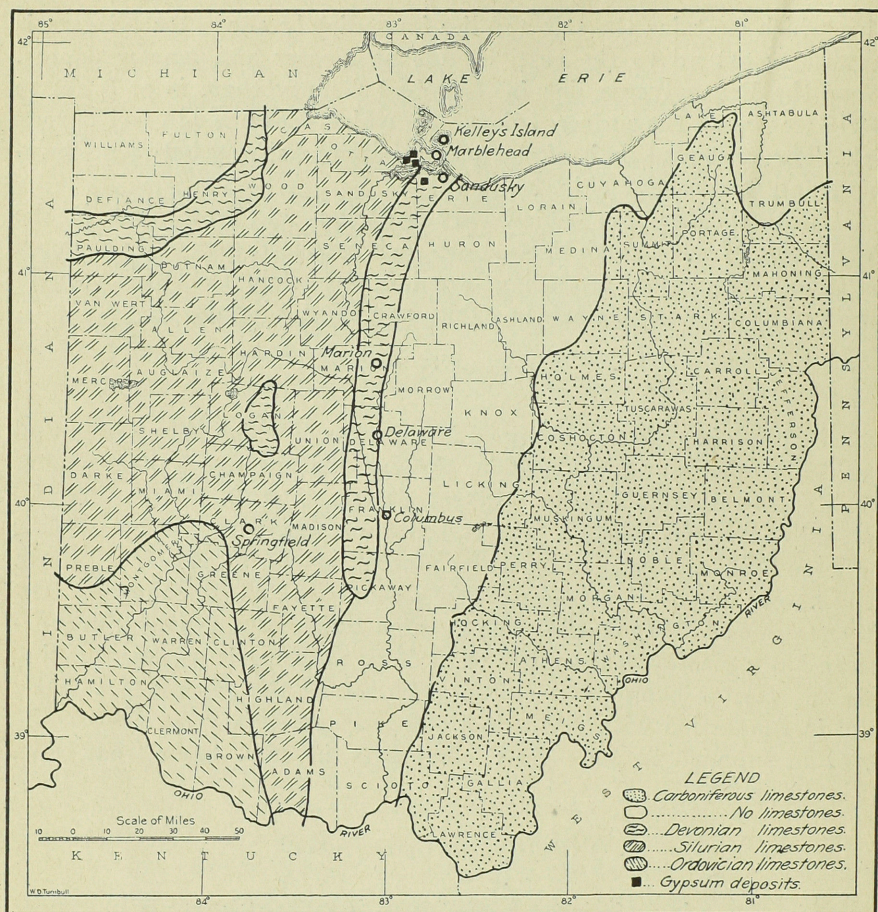


Fig. 23—Limestone and Gypsum deposits

Though the Devonian limestones do not cover as much area as the Silurian they are nevertheless of great importance. They outcrop in a belt running from Pickaway to Erie County and the formations known as Columbus and Delaware are quarried at Columbus (Marble Cliff), Delaware, Owen Station, Marion, Sandusky, Marble Head, Kelley's Island, and other places. Except for the top 5 or 6 feet the rock at Columbus has such purity of calcium carbonate that it is the basis of a very large industry which supplies flux to blast furnaces. Devonian limestone is also quarried in Logan and Lucas counties in northwestern Ohio.

The Mississippian and Pennsylvanian rocks do not have thick limestones, hence they are worked only locally. The Maxville, Putnam Hill, and Vanport limestones, the most important, are but little used. The Lower Freeport limestone, which is found only locally, is used in Columbiana County in small quantities for natural cement. In total the coal

measures contain rather large amounts of limestone but in most places the layers are so thin and separated that under present conditions they are of slight value. However, Portland cement industries are established on these beds at Ironton, Lawrence County, and Middlebranch, Stark County.

(The use of limestone in Ohio as flux is great. Almost two and a half million dollars were spent for this purpose in 1920. As a flux it has three markets: (1) It is shipped to the metallurgical industries of Lake Superior in ships that would otherwise go back empty; (2) it is consumed in enormous quantities in making pig iron in blast furnaces of Ohio and western Pennsylvania; and (3) in fine form it is used by bottle and glass factories. Other large uses are as crushed stone for railway ballast, road metal, and concrete. There are, because of the small capital necessary and the distributed market, a large number of crushers about the State.)

Value of limestone produced in Ohio in 1920

Crushed stone-----	\$3,282,500	Glass works-----	\$25,068
Flux-----	2,483,841	Rubble and riprap-----	22,606
Agricultural stone-----	78,891	Other uses-----	502,000
			<hr/>
Total-----			\$6,415,233

Total value of limestone produced from 1900-1920

1900-----	\$1,964,387	1910-----	\$4,357,432
1905-----	2,805,793	1915-----	4,405,590
1920-----	\$6,415,233		

CEMENT

Portland cement is commonly made from a mixture of about 75 per cent limestone and 25 per cent shale or clay. It is also made from marl which has naturally about the desired proportions of lime and clay substance. In Ohio, Portland cement is made at five places. At Ironton, Lawrence County, it is manufactured from Maxville limestone and clay, the former being obtained from a shaft 510 feet in depth. The other factory in Lawrence County is at Superior and uses Vanport limestone and shale or clay, all secured from drift mines. The materials used at Middlebranch in Stark County are Vanport limestone and shale which are quarried from surface workings. The two plants in Erie County, one at Baybridge and the other at Castalia, use marl for the raw ingredient.

Natural rock cement is made at one place in Ohio—Lisbon, Columbiana County. The process of manufacture is simple and the outlay not large. There, shaly limestone is burned in a kiln similar to that used in making caustic lime. Natural rock cement is used most largely by manufacturers of safes and burial vaults.

In 1919 Ohio ranked eleventh in value of cement produced. The value was \$1,637,418 which was an increase of 14 per cent over the previous year. The State consumed 6,258,862 barrels or 1.09 barrels per capita, which was 4,437,265 barrels more than it produced.

LIME

Ohio stands second among States in the burning of lime. In 1920 its 33 plants produced lime to the value of \$4,477,987. In that year 558,892 short tons were sold, of which 333,203 were shipped from the State though 83,165 tons were imported. Building operations in the State used more lime in 1920 from the point of view of value than all other industries put together. These were in order of value: glass manufacture, agriculture, paper mills, metallurgy, and chemical industries.

The process of lime burning consists of roasting or calcining limestone so as to drive off the volatile constituents, leaving calcium and magnesium oxides in an uncombined state. Such a product is known as caustic lime. By treating this with water or steam a calcium hydroxide, known as hydrated lime, is formed. Limestones containing 85 per cent or more of calcium carbonate combine with water so vigorously that considerable heat is evolved and these are known as "hot" or "quick" limes. Lime produced from dolomitic limestones, having 30 to 45 per cent magnesium carbonate, reacts slowly with water and hence is known as "cool" or "slow" lime. The dolomitic or "cool" lime industry of the State is much larger than the high-calcium or "hot" lime industry. This is partly because of the greater markets for "cool" lime, and partly because an inherent quality makes it easier to store without danger of serious slaking.

The "cool" limes are burned from Silurian limestones mainly of Greene, Clark, Wyandot, Seneca, Sandusky, and Ottawa counties. The "hot" limes are obtained from the Devonian limestones mainly of Delaware, Marion, Erie, and Ottawa counties.

BUILDING STONE

(The building stones of Ohio are sandstone and limestone, including dolomite. The limestone comes principally from the west half of the State.) It varies so much in physical and chemical characteristics that it is difficult to generalize regarding it. The colors range from gray-white to buff and to dark blue. It does not carve well. Hence, the market is almost local. Though durable and of great crushing strength, many of the sandstones contain concretionary iron and other objectionable material. The Berea and Cuyahoga alone are important.

Limestone.—The Ordovician rocks of southwestern Ohio were at one time quarried extensively for building stone. Not a few of the

better buildings in Cincinnati of the last century were of this material. Though the rocks cover 4,000 square miles they are little used today, largely because of their uninteresting appearance and the great amount of shales associated with them. The Silurian limestones cover a large part of the western half of the State. The Brassfield ("Clinton"), the oldest member of the Silurian, has been quarried near Dayton and Piqua, and the Niagara limestone has several workable members. One of these, the Dayton stone, makes excellent building material except for the presence of iron pyrite which rusts on exposure. It has been obtained in the vicinity of Centerville, Dayton, and Xenia, and while the market has extended over western Ohio and part of Indiana, today the consumption is slight. The Springfield member is much like the Dayton but contains less pyrite and has a more pleasing appearance. Its main development and market have been about Springfield. Quarries in Niagara limestone are also located at Covington, Ludlow Falls, Piqua, New Paris, Eaton, and Hillsboro. Each of these has yielded building stone. The Monroe formation of the Silurian limestone, though having a thickness of 300 feet, has been quarried for building purposes in but one locality, Greenfield, Highland County.

The Columbus formation of the Devonian is used for buildings and is so bedded and jointed as to aid quarrying. Physically it is crystalline, takes a fair polish, has many fossils, is colored gray to buff and light blue, and has excellent durability. Though used in the rough in domestic architecture, its finest employment is seen in the State House where it is the material for the walls and the massive columns. The Delaware member of the Devonian is much like the Columbus. The important quarries in these two last formations are near Columbus, Delaware, Marion, Sandusky, and Kelley's Island.

Of the Mississippian there is only one limestone member whereas in the Pennsylvanian there are several. All are little used today. Indeed the quarrying of limestone for building purposes within the State is a desultory business of slight importance. In the words of one old man, the third generation of quarrymen, as he looked over his quarry now abandoned to weeds, "No one seems to want our stone any more."

Sandstone.—The sandstones of Ohio of use for structural purposes are obtained from the Mississippian and Pennsylvanian rocks, mainly from the former. The Berea sandstone is the best known of the building stones of Ohio and one of the best known in the United States. The bed outcrops along an irregular line from Trumbull to Erie County, and thence south across the State to Scioto County, with a width which varies from a fraction of a mile to 11 miles. It is thickest in the northern part of the State. In color the stone is of uniform blue-gray which weathers to a light buff. The principal quarries are in Cuyahoga and Lorain counties where excellent outcrops occur near large city markets and trunk railways. This sandstone has been quarried also in Trumbull,

Ashtabula, Geauga, Erie, Richland, Crawford, Morrow, Delaware, Franklin, Pike, and Scioto counties. For 75 years it has been marketed on a commercial scale. Buildings as widely distributed as the Canadian Bank of Commerce in Winnipeg, the John Hancock Life Insurance Building in Boston, St. Mark's Church in Washington, D. C., and the Teutonia Life Insurance Building in New Orleans bear testimony to its excellence. Local examples of its use are in the Ohio National Guard Armory of Cleveland and Orton Hall of Ohio State University at Columbus. This last building uses Dayton and Springfield limestone in its substructure and Cuyahoga sandstone for trimmings and the lobby has incorporated in its stone work examples of all of the principal building stones of Ohio.

Of the other Mississippian sandstones there is one older, the Bedford, and two younger, the Cuyahoga and Blackhand (conglomerate), which have commercial value for structural purposes. The Pennsylvanian rocks have a large quantity of coarse-grained sandstones which are well adapted for building and which have been extensively quarried for almost purely local markets.

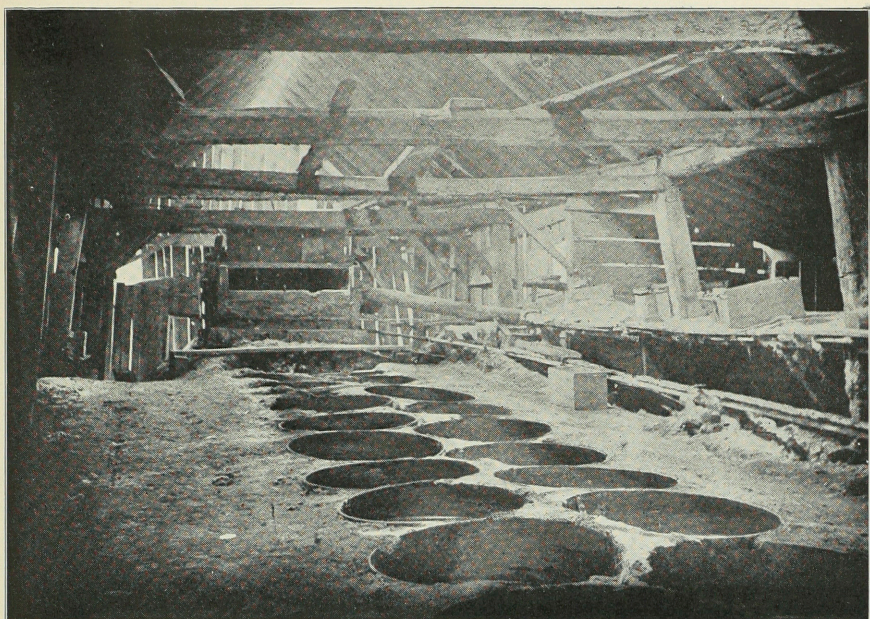
In 1920 the 23 plants had an output which gained for the State second place in the value of sandstone produced, the value being \$1,513,615, of which \$702,693 represented rough and dressed building, \$656,553 curbing and flagging, and the remainder riprap and rubble. Building stone in a State noted for brick manufacture and in an age of cement must decline in relative importance.

ABRASIVES

From its sandstones Ohio produces grindstones, pulp stones, oil stones, and scythe stones. Grindstones and scythe stones are obtained largely from the Berea, though Pottsville, Monongahela, and Dunkard beds are also worked for this purpose. The principal region for production is in Cuyahoga and Lorain counties, but other quarries are in Holmes, Morgan, and Washington. In 1921, Ohio produced 93 per cent of the grindstones of the United States. The pulp stones, used in the grinding of wood to pulp, are cut from Pennsylvanian rocks and come from Carroll, Columbiana, Jefferson, Morgan, and Washington counties. These are shipped in large quantities to Canada and even find so distant a market as Japan.

SAND AND GRAVEL

The total value (\$6,434,627) of sand and gravel produced in the State in 1920 is surprisingly large and Ohio ranks first in this industry. Of the total, the gravel in 1920 represented less than 29 per cent, more than half of which was used for building purposes and the remainder



A—An old salt furnace in Morgan County. This shows the kettles used in evaporating the brine. (Photo by Bownocker)



B—Cutting stone in Columbiana County. The round stones are for grinding wood into pulp.

for paving and railway ballast. The principal source of the material is the glacial gravel found over three-fourths of the State.

The sands have a greater variety of uses and a larger total value. In order of importance the uses are for molding, building, furnaces, paving, grinding and polishing, and manufacture of glass. The shipment of sand is largely for molding purposes. Sands are obtained in various places. In Erie and Ashtabula counties the fine sands of the glacial lakes which preceded Lake Erie are recovered for molding finer castings. Sands for similar purposes but of different origin are worked on a large scale in Muskingum County. A great source of molding sand is found in the Pottsville, which is quarried and crushed in Trumbull, Portage, Geauga, Summit, Knox, Tuscarawas, Perry, and Jackson counties. In two counties, Tuscarawas and Perry, the poorly cemented sandstones of Alleghenian age are treated in the same way and for the same purpose. In Gallia County, in the southeast, and Butler and Hamilton counties, in the southwest, surface deposits of sands of water, wind, or glacial origin are sold for moldings.

CLAYS AND SHALES

Ohio clays and shales make the State the center of ceramic industries of the United States. Ohio ranks first among the states in value of output and the ceramic industry is second among the industries of the State. This is in part due to the wide distribution and excellence of the clays and shales and in part to other factors such as fuel, water, shipping facilities, and labor.

Value of Ceramic Products of Ohio: 1900-1920

	<i>Pottery</i>	<i>Brick and Tile</i>	<i>Total</i>
1900.....	\$8,573,323	\$9,731,305	\$18,304,628
1910.....	14,294,712	17,231,236	31,525,948
1920.....	41,229,803	40,832,157	82,061,960

The value of the products in 1920 was 22 per cent of the total for the United States.

The ceramic industries of the State depend upon three different types of materials, common clay, shale, and coal formation clay. The general term *clay* is applied to earths or unconsolidated rock which consist of particles finer than sands, most of which have plasticity when moist and which will consolidate to hard masses when burned. *Shales* consist of clay that was laid down in thin layers and then hardened into rock. *Coal formation clays* are directly associated with coal beds and are derived from clay sediments which have been purified by the action of plants and swamp waters of the coal age. They are distinct from shales in that they lack the thin bedding, generally have greater plasticity, and always burn to a buff color.

Clays and shales are the disintegrated products of other rocks. Residual clays are those products of weathering which are in place, that is, a limestone weathering will be leached of certain components and the residual mass will be clay. Alluvial clays are those products of disintegration which have undergone a sorting by streams and may be derived from a variety of rocks. They have, because of the two processes involved, been sorted both chemically and physically. Glacial clays are a chemical heterogeneity. They consist of rock flour derived by grinding the rocks over which the glacier has passed. The shales of Ohio are derived from clays which were deposited in still water and which have been sorted by the action of waves and currents. The coal formation clays are derived from the muds of swamps in which the coal making plants once thrived. The action of the plants and the swamp waters is such as to withdraw from the deposits amounts of lime, magnesia, silica, and iron oxide, thus increasing the percentage of alumina and so raising the fusion point.

The clays of the coal formations burn to a buff color because of their low iron content. They are used for the manufacture of stoneware, fire brick, sewer pipe, terra cotta, yellow ware, fire proofing, flue lining, and building brick which varies in color from buff to gray.

The shales of Ohio are red burning and are used extensively for paving brick, building block, vitrified building brick, drain tile, and sewer pipe. The common clays, alluvial, residual, and glacial, are converted into common building brick and drain tile.

The clays of western Ohio are all red burning. The surface is covered with glacial drift and near every hamlet or town there is one or more brick or drain tile kilns. The product is of low grade and though a large quantity is manufactured, the wide distribution of raw materials and markets prevents a centralization of the industry.

Shales.—The shales are found in central and eastern Ohio. Geologically they are distributed from the upper Devonian to the top of the Pennsylvanian. Though there are many ceramic plants throughout the Pennsylvanian areas of southeast Ohio as well as a scattering of localities in the older rocks to the west, there are four places where larger developments of the shale industries have centered. These are at Portsmouth, Canton, Akron, and Cleveland. At Portsmouth the beds which are worked have a thickness of 300 feet and the industry is largely the production of paving brick. At Cleveland where the shales are 50 to 100 feet thick, the beds are particularly adapted for paving brick and building materials. At Akron, from a bed of 30 to 40 feet, has been developed one of the largest centers of sewer pipe manufacture in the world and today the largest single plant still operates there. At Canton the Pottsville shales are largely employed for fire proofing and building brick.

Coal formation clays.—Of the coal formation clays there are 13

beds which are worked. These vary from 3 feet to 20 feet in thickness and like the coal beds they are in some cases persistent but in others they do not extend over great areas. Like the coal, there are workable beds in every county in the southeast but the principal counties are Summit, Stark, Columbiana, Jefferson, Tuscarawas, Carroll, Coshocton, Muskingum, Perry, Hocking, Athens, Jackson, Lawrence, and Scioto.

Of the 13 beds, the Lower Kittanning (No. 5) clay and its associated shales are by far the most important. Orton said of this bed:

"Its importance far outweighs that of any other clay seam. Indeed, it is probably equal in value to all other sources of clay in the coal measures combined. * * * In its more important fields it ranges in thickness between 8 and 30 feet. In some districts it is merged, with only the interruption of the Lower Kittanning coal seam, into the clays that belong to the next ascending series. * * * In this case the combined deposits constitute a section measuring not less than 50 feet. The Kittanning clay horizon is seen at its best where it enters the State from Pennsylvania, and again where it leaves the State in its extension into Kentucky. In both of these localities, viz., in Columbiana and Jefferson counties on one side, and on the other, Lawrence County, it shows large volume and excellent quality."

The outcrop of the Lower Kittanning clay crosses the State without a break and is the basis for more than 100 ceramic plants. Some of the more important centers are in Lawrence County (Blackfork), Jackson County (Oak Hill), Hocking County (Haydenville and Greendale), Athens County (Nelsonville), Perry County (Roseville and Crooksville), Coshocton County (Coshocton), Tuscarawas County (Uhrichsville, Dennison, Mineral City, and Dover), Stark County (Waynesburg, Minerva, and Magnolia), Carroll County (Malvern), Columbiana County (Lisbon, Wellsville, and East Liverpool), and Jefferson County (Empire, Toronto, and Irondale). Toronto, Empire, Uhrichsville, and Dennison form the great sewer pipe centers of the State. Roseville and Crooksville manufacture large quantities of stone and yellow ware.

The best coal formation clay of the State for general purposes is the Tionesta which is the basis of the great industries about Shawnee, Roseville, and Crooksville (Perry County) and Zanesville (Muskingum County). This region, manufacturing a variety of products, is one of the greatest ceramic districts in the United States. One factory alone has an output of a car load of stoneware and pottery an hour.

Ohio has unlimited resources of coal formation clays and shales which are adapted to the manufacture of a large variety of ceramic products. This is not true of much of the adjacent areas which must be supplied from Ohio fields. Western Ohio, most of Kentucky, parts of Indiana, Tennessee, and beyond are lacking in clays of this type. Today sewer pipe is shipped even to California. Along the entire Atlantic coast there are not as many plants for the making of this product as there are at Dennison alone. (Fig. 21, p 66)

MINERAL WATERS

The greatest number of commercial springs in any one state is 38. Ohio in 1920 was operating 24, was sixth in rank, and produced 2,300,000 gallons for the year. The localities where water is bottled are scattered about the State. The commercial value of a spring depends to a large degree upon the distance from the markets, thus five are near Cleveland and near-by cities and two are near Toledo. Columbus, Newark, Zanesville, and Chillicothe are each served from the immediate vicinity.

Bibliography on Mineral Resources

Most of the material for the mineral resources comes from the publications of the Geological Survey of Ohio. Volume V of the second series was used for the story of the early iron industry and all the bulletins of the fourth, or last, series pertaining to the geology of economic products have been followed closely. "Mineral Resources" and "The Coal Fields of Ohio" by J. A. Bownocker (Professional Paper 100-B, 1917) were the publications of the United States Geological Survey which were of the most value. Dr. Bownocker has articles on oil and gas in the following publications which have been of service: Bull. Geol. Soc. of America, Vol. 28, 1917, pp. 667-676; Nat. Gas Assoc. of America, May 20, 1909; American Geologist, Vol. XXXI, 1903, pp. 218-231; and Mining and Metallurgy, Feb. 1920, No. 158. For the material on clay I am indebted to Mr. Wilber Stout of the Geological Survey of Ohio.

CHAPTER V

TRANSPORTATION AND THE DEVELOPMENT OF INDUSTRIES

EFFECT OF EARLY ISOLATION UPON INDUSTRY

The Ohio country before 1830 had been forced to achieve almost complete economic independence. There lay between the frontier and the thirteen colonies the Allegheny Mountains and Plateaus, both covered with a heavy forest. The Alleghenies were long parallel ridges, across which there was no general corridor. The streams which broke across the mountains completely filled in places the valley bottoms at the narrows, or water gaps. The wind gaps were mere notches in the mountains and a goodly portion of the steep-sided mountain had to be scaled before such a pass was reached. Once over the mountains there lay to the west before the plodding caravan the plateaus which everywhere were deeply cut by streams. The level land between streams was not continuous and the narrow valley bottoms were almost entirely occupied by rivers. In addition the country was covered with a confusing and impeding forest. Roads had to be literally chopped and grubbed from the woods before leveling could be started. The Ohio River and its group of widely reaching tributaries at its head was the saving grace of the situation.

Thus the settler in the wilderness, cut off from centers of civilization, lived not alone by the sweat of his brow but by his ingenuity. The earliest wood-products industry was a one man affair, or at best, the concerted action of the small community, for the house was made of logs. The floor, at first of dirt, was later of puncheons, that is, axe-made boards. Wooden pegs served as nails. Tables and benches were made from poplar or beechwood and the buckeye tree was used for bowls and plates. In the winter, hunting and trapping were principal occupations, but between expeditions the settler turned his hand to making wooden ware for household use and staves for flour and whiskey barrels and to the manufacture of wood ash for lye and soap. There soon was a surplus and for these commodities outside markets were sought. As early as 1800 there was a factory for tables, desks, and other furniture at Cincinnati and shortly after plows were being made on a commercial scale in the same town.

The land was cleared with the aid of fire. The wood ashes were leached and boiled to black salts which were sent east. Some of the product was used in making hominy. The early grain was ground for local consumption. Excess grain was fed to cattle and swine which

in turn walked to market. The first mill constructed was in 1789 on Wolf's Creek near its junction with Muskingum River. In 1791 a curious mill wheel suspended between two boats which were moored in the Ohio at the mouth of the Hocking ground 20 to 50 bushels of corn a day. The first mill which offered a cash market for wheat was built at Venice, Sandusky County, and when in 1833 flour from this mill arrived in New York it caused much comment.

Early textile manufacture was at first carried on in every locality and on practically every farm. Flax was grown almost as generally as corn. This was spun and woven on the farm where it was harvested. Mixed with wool it formed the "linsey woolsey" of not so many years ago. "Jeans" were made of wool and cotton. It is significant that in 1805 Pittsburgh manufactured \$1,200 worth of spinning wheels. In 1810 Chillicothe had a cotton mill which spun 720 dozen yards a week.

The first woolen mills were set up at Steubenville about 1812, and one of the earliest operators in Ohio was the grandfather of William D. Howells, the novelist. There were small woolen mills in all of the larger settlements. Broadcloth was made the official garment for weddings, funerals, and other momentous events—the one piece of cloth serving several generations.

Hemp was grown locally until the competition of slave-grown hemp of Kentucky became too great. At Marietta there were rope walks where men walked back and forth winding the rope and also walks were established at Springfield and Xenia.

The first brick made in Ohio, so far as is known, was burned at Marietta in 1788. Brick making was an early industry everywhere. As soon as the original log cabin was outgrown or the prosperity as based upon the wonderfully productive soils called for better living conditions, brick houses were erected. More than likely the farmer with the help of his neighbors made his own brick. One summer it was burned, the following summer the house was built, and the farmer's wife had the privilege of cooking for large numbers in two successive hot seasons.

The basis of early manufacturing was supplying the wants of these isolated agricultural communities and the prosperity of the fertile Miami Valley concentrated many of the early factories in that territory. Before 1812 manufacturing was of the household or small shop type but after 1815 factories began to appear. In 1794 a man was advertising in a Cincinnati newspaper for an assistant tanner. In the next year an advertisement of a pottery appeared. Shortly blacksmiths, millers, saddlers, potters, gunsmiths, and cabinet makers were in evidence. The beginning of the brewing industry, so important to Cincinnati at a later date, was in 1806. Flour, flaxseed oil, glass, bells, brass, and iron were all made at an early date. Of the three classes in which the early census of 1820 placed people, farming, commerce, and

manufacturing, the counties of the lower Miami Valley had the following percentages engaged in manufacturing:

Warren County—21 per cent	Darke County —15 per cent
Hamilton County—20 per cent	Greene County —14 per cent
Clermont County—20 per cent	Champaign County—14 per cent
Preble County—11 per cent	

But this was not to last long. River travel was soon developed. Roads were to be built, canals, and shortly after, railways were to break down the isolation of these forest clearings. Though the building of rafts and boats was carried on along every little river by the farmers who planned thus to export their produce, it was at Marietta, and to a lesser extent at Cincinnati, that shipbuilding became an established industry. Commercial restrictions at the mouth of the Mississippi and the coming of the steamboat in 1811 blocked the progress of the industry. Nor were these boats for river trade alone. The first ocean going vessel which left the ways at Marietta was the brig *St. Clair* of 110 tons, constructed of Muskingum oak and rigged with Ohio hemp. This manufacture of boats for the sea was partly in an endeavor to avoid the ravages of the Spanish middlemen at New Orleans. The *St. Clair* disposed of her cargo at Havana. The log of the sailing ship *Louisiana* of Marietta has been preserved for us. In 1805 she started a tour which included New Orleans, Norfolk (Virginia), Liverpool, Messina, and Trieste. Before the critical days for the American Marine in 1802, Marietta sent to the sea seven large sailing ships, eleven brigs, six schooners, and two gunboats. Perhaps this was one factor in the relationship which Ohio showed to the sea in 1840 when the census discovered 212 of her citizens as sea-faring men.

Thus before 1830 the following factors combined to give birth to the infant industries of the Ohio territory: 1. The rising tide of immigration. 2. The difficulty of obtaining goods from the east. 3. The great cost of the long hauls. 4. The necessity of creating a home market to save the cost of exporting surplus agricultural products.

RIVER TRAFFIC

The rivers have exerted a profound influence upon Ohio. Every tributary of *la belle rivière*, the Ohio, and every stream flowing into Lake Erie, was an avenue of canoe travel inherited from the Indians. Later the pirogue, a large canoe hollowed from a log and manned by several men, carried woodsmen and their captured pelts up and down the stream. But largely it was the Ohio River, and to a lesser extent the Muskingum, Miami, and Scioto, which was the basis of that river traffic so important to the early development. This travel at first was to a surprising degree purely down stream.

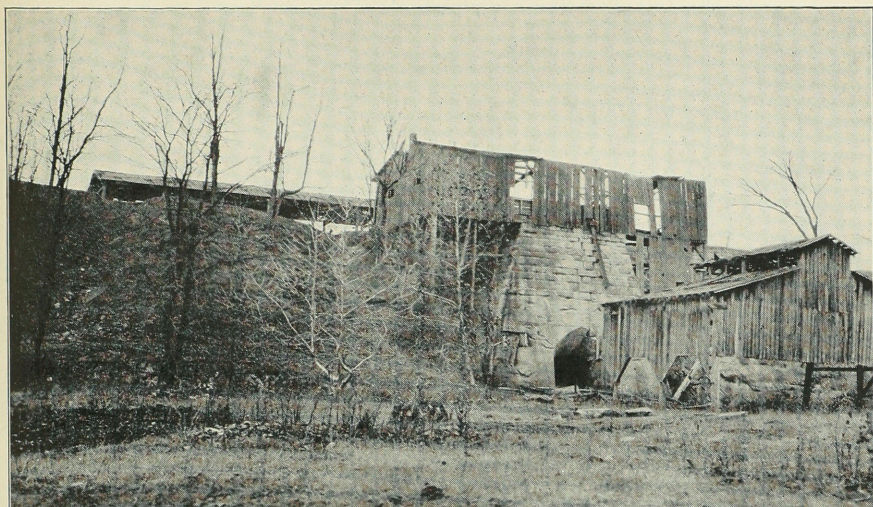
Boats were at first mere rafts. Later the barge or batteau of forty and fifty and, in rare cases, of one hundred tons burden were built. These were constructed during the winter by the woodsmen-farmers of a community and floated down with the spring freshet, to join in the procession to New Orleans. Many of these were built along creeks which were insignificant except for one week in the spring and which now, because of deforestation, have dwindled. Most boats never returned but were broken up for lumber at their journey's end—the men returning home overland.

Later a class of rivermen developed which built and propelled boats for a living. Flat boats known as "broad horns" from the steer's horns fixed to the end, and keel boats which were smaller, more ship-like in appearance, and could pass up the tributaries, were developed. These boats were brought up stream by poling, the use of sweeps, or by "cordelling," that is, towing as one "bushwacked" one's way along the shore. The trick of coming up stream with the back eddies on the inside of the river's meander curve was soon learned. It was slow and arduous work, but these were the days when " . . . every man was half a horse and half an alligator."

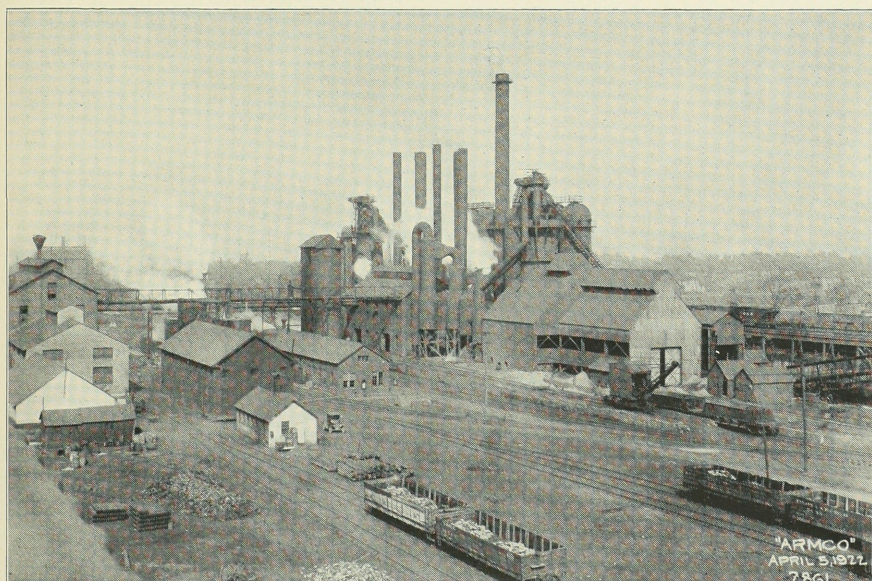
The farmer turned manufacturer in the winter, preparing his food-stuffs for the trade. He trapped and cured his pelts; with the aid of water power he turned miller to make flour; he sawed lumber. The hogs were slaughtered and the meat cured. Whiskey, cider, and peach brandy were shipped in wooden barrels or clay jugs—the containers as well as the contents being home made. When not farming, some dug iron ore, while others made salt for shipment.

These materials went down river. In the first four months of 1802 Cincinnati expressed 4,000 barrels of flour; in 1811 a brewery turned out 5,000 barrels of beer and porter; and in 1812 pork packing in the Miami Valley was done on a large scale. In 1824, Ohio as a whole shipped 3,000,000 barrels of flour down stream. This was equal to one-fourth of all the products descending the Mississippi River. It was estimated that 3,000 boats and barges annually descended the Ohio. Nor was the trade entirely one-sided. Slowly but surely keel boats came up stream with small loads from New Orleans. In this way much molasses, some sugar, coffee, lead for bullets, and a few luxuries, found their way to the Ohio frontier.

But in 1812 when the little *New Orleans*, the first steamboat on the Ohio, came puffing down the river from Pittsburgh, a new era was ushered in. It was not until 1817 that the experimental stage in steamboats was past. But with the construction of the *Washington*, the round trip from Pittsburgh to New Orleans was made in 41 days; whereas by the old way it had taken 6 months. However, little freight was carried until 1819. Indeed the barge still plays a part in river traffic, but the keel boat did not long survive the introduction of the propelling



A—An abandoned iron furnace in Jackson County. This is the type of iron furnace which flourished 50 years ago, burning charcoal instead of coke, and working with local ores. Today they are desolate. (Photo by Stout)



B—A modern iron furnace at Columbus. In such a plant the ore, coke, and limestone are burnt together and pig iron obtained. (Courtesy of the American Rolling Mill Co.)

of boats by steam, for in the period from 1820 to 1840 the traffic down stream was accomplished in the more economical and larger barges. Such upstream travel as was necessary was done in the steamboat. Men loaded their barges at the river town with farm produce and such articles as were manufactured in the home. As many as 10 and 20 barges were to be seen tied to the river bank before towns. The men then traded their way down stream and, when once their cargo was disposed of, took the steamboat back.

Number of steamboats built on the Ohio River in certain years

1811-----	1	1817-----	7	1821-----	5	1825-----	27
1814-----	1	1818-----	25	1822-----	13	1826-----	56
1815-----	2	1819-----	34	1823-----	15	1827-----	36
1816-----	3	1820-----	10	1824-----	16		

In the 20 years between 1840 and 1850 river transportation reached its zenith. The boats of 1850 little resembled the primitive *New Orleans*. Such boats as the *Sultana* and the *Southern Belle* were huge, gaudily ornamented palaces worth \$50,000 and carrying cargoes worth five times that amount. The *Yorktown* built in 1844 for the Ohio-Mississippi trade was typical of the epoch. Her length was 182 feet, breadth at the beam 31 feet, and she was propelled by wheels 21 feet in diameter. Yet the boat drew only 4 feet of water when light and 8 feet when loaded with 500 tons of freight. In the early fifties rail connection was established between the upper Ohio and the east coast. The steamboat then reached its heyday, and a shipping service was established on the river, which was responsible for the initial growth of many Ohio cities. Such towns as Bellaire, Pomeroy, Middleport, Gallipolis, Ironton, and Portsmouth owe much to the river.

It was several decades later that a railway paralleled the Ohio. This, however, was on the West Virginia-Kentucky side and connected with the towns mentioned only by ferry. There is no through line today on the Ohio side from Bellaire to Cincinnati. With the decline of river traffic, caused mainly by rail competition, the cities between Bellaire and Cincinnati have languished or at least lost their rank in this State of actively growing urban populations. In more recent times some of these towns have revived, as Marietta because of the surrounding petroleum resources, and Portsmouth which in the last 20 years has grown notably. This last city is the site of a large shoe industry and of repair shops of the Norfolk and Western Railway. The towns which had long wharves sloping to the river once covered with freight are now turning about-face and building better roads so as to gain the trade of the valley farms, and are agitating for better rail communication. When President Harding made a pilgrimage to the birth place of General Grant on the occasion of the centennial celebration (1922), he took the only practical method of reaching Point Pleasant, that is by river boat.

ZANE'S TRACE AND THE NATIONAL HIGHWAY

The immediate problem, which in those critical days confronted every farmer and every growing community, was the matter of roads. To clear a wagon trace of the trees and stumps, level and grade the road-bed, pass the marshy places and bridge the streams, called for time and money, which the pioneer could ill afford to give. The early roads were unbelievably bad. The ox and clumsy wooden cart plodded along more successfully than the horse and wagon but "heavy rains would fill each rut with water and the next wagoner would push his horses in this slough, perhaps exploring it with a pole to see if a bottom was to be found." Harriet Martineau in her travels in America quaintly said, "There is a variety of roads in America. There are the excellent limestones of Tennessee and Kentucky. There are the rich mud roads of Ohio, through whose sloughs the stage coaches go slowly, and gently upsetting when the rut on one side or the other proves to be of greater depth than was anticipated. There are the corduroy roads, happily of rare occurrence, where if the driver is merciful to his passengers he drives them so as to give them the association of being on the way to a funeral, their involuntary sobs on each jolt helping the resemblance, or if he be in a hurry he shakes them like pills in a box."

In 1811 there was neither bridge nor pleasure carriage within one hundred miles of Franklinton (Columbus). The roads were nearly impassable. One of the greatest problems of the time was the shipping east of surplus agricultural products. The cheapest way to ship grain was to feed it to cattle, and to send it "on the hoof," and cattle passing over the roads either created clouds of dust or in wet weather, marching in rank and file as they do, they stepped in the hoof marks of those that preceded them. Thus when the road dried, its surface consisted in places of steep pits stamped by the cattle, and was almost impossible for vehicles.

In the black swamp country of the northwest conditions were at their worst. Horses, mired to their bellies, strove to drag the wagons to and from the mills where the settler ground his grain. Ten miles a day was good progress, and that one stretch of 31 miles in length had 32 taverns to shelter the beleaguered traveler tells the story eloquently. A good mud hole opposite one's farm might be a source of income, the revenue being derived from pulling people out.

One of the first pikes was built from Warren to Lake Erie. Other early roads ran from Ohio City to Columbus, Columbus to Sandusky, Cincinnati to Zanesville, and Sandusky to Perrysburg. An important road ran through Cincinnati and Lebanon and Xenia to Springfield. In June, 1807, we find the following post roads in Ohio: (1) From Chillicothe to Franklinton and thence to Washington, (2) from Chillicothe, via Brown's Crossroads, Williamsburg, Columbia to Cincin-

nati, (3) from Cincinnati via Hamilton, Franklin, Dayton, Stanton, Springfield, Xenia, Lebanon to Cincinnati, (4) from Chillicothe to Wheeling and beyond. Chillicothe was then the political center of the State and Cincinnati the industrial center. In 1822 a road was commenced from the Western Reserve of the northeast to the Maumee River. It was along this highway in 1832 that there were 32 inns within 31 miles but none of these lines of travel deserved the name of road.

Such conditions did not last long. In 1835 this worst of roads was so improved that as many as 90 pioneer wagons might pass along in a day. Charles Dickens tells of driving in 1842 on an excellent macadam road from Cincinnati to Columbus. From Columbus north his experience was not so happy. He speaks of the carriage "falling" from log to log where the road had been corduroyed.

Zane's Trace.—Zane's Trace began at Wheeling, a town which was owned by the Zane family. The need of a road which would permit those who had gone down stream on the Ohio to return directly overland was greatly felt and the wilderness road on the south was too round-about. Colonel Zane was commissioned by the Government to blaze this trace through the forest. The route lay from Wheeling through St. Clairsville, Morristown, Fairview, Washington, Cambridge, New Concord, Norwich, Sonora, Zanesville, Putnam, Lancaster, Tarlton, Kingston, Chillicothe, Union, Manchester, and so finally to Aberdeen in Adams County on the Ohio River. Though at first this was hardly more than a trail, improvements soon followed. At wet crossings corduroy roads of saplings were laid, bridges were built, and ferries established. An early traveler over Zane's Trace gives us a vivid description, "We started back to Pennsylvania on horseback, as there was no getting up the river that day * * * There was one house (Treber's) at Lick Branch five miles from where West Union now is * * * The next house was where Sinking Springs now is. The next was at Chillicothe, which was just then commenced. We encamped one night at Massie's Run, say two or three miles from Paint Creek, where the Trace crossed the stream. From Chillicothe to Lancaster the Trace then went through Pickaway Plains * * * There was a cabin three or four miles below the plains and another at their eastern edge, and one or two more between that and Lancaster * * * Here we stayed the third night. From Lancaster we went the next day to Zanesville, passing several small beginnings. I recollect no improvement between Zanesville and Wheeling except one at the mouth of Indian Creek opposite Wheeling." (Fig. 24, p. 94)

For forty years this was the main highway for commerce and trade in the center of the State. The Trace was the first of "internal improvements" in Ohio country. Along its course before it could be called a road, long pack trains of horses passed. As the tide of settlers

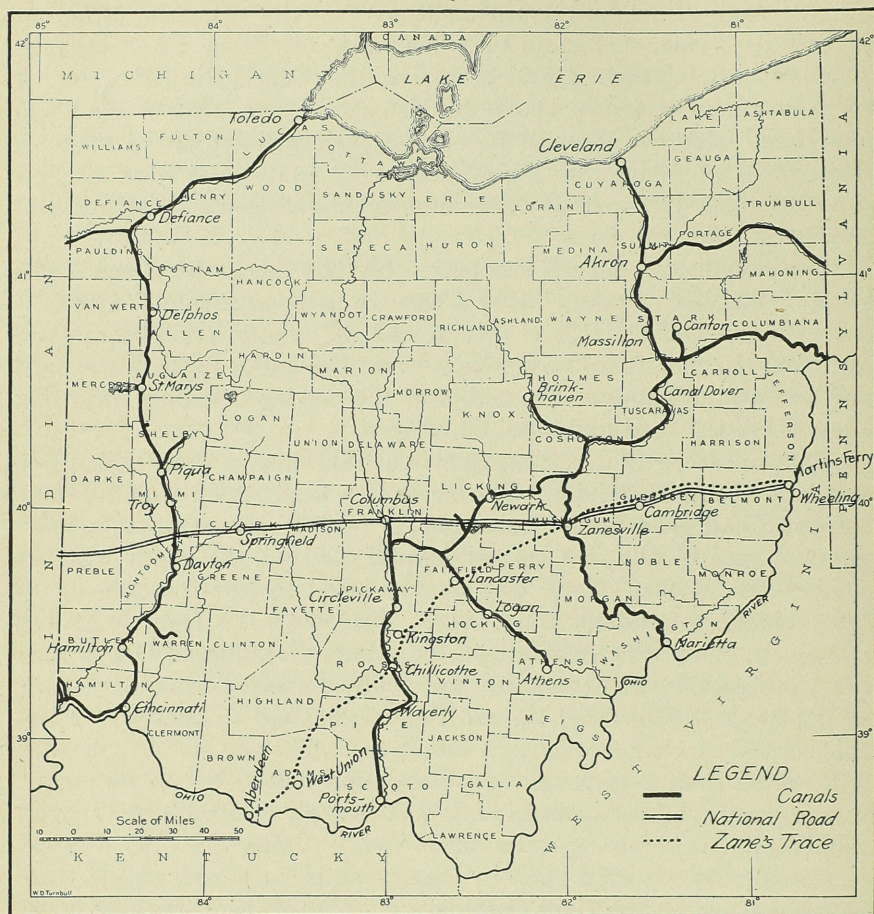


Fig. 24 —Zane's Trace, the National Road, and the Canals

poured through Wheeling the Trace became widened to a road, taverns sprang up, especially where there was the possibility of a ferry across some stream. The inn keeper had a few staples to sell. It was this inn and primitive commissary which was the beginning of many a town. The first settler in Pickaway and the pioneers of Fairfield County came by this route. Cambridge is built on the site of a tavern which was located where the Trace crossed Will's Creek. St. Clairsville was formerly Newelsville where Newel built a tavern. Three sections were given to Colonel Zane in return for his services as pathfinder, one at the crossing of the Muskingum (Zanesville), a second at Standing Rock at Hockhocking (Lancaster), and a third on the Scioto at Chillicothe. Settlers moved to Zanesville in 1797 and set up a ferry there. McIntire, son-in-law of Zane, with his own hands built a tavern and distinguished it by putting glass in the windows.

As Ohio has profoundly affected its people so have the people profoundly affected Ohio. The tavern keepers, by means of their contact with the traveler, had a great influence upon the people. One cannot help mentioning Sarah Zane McIntire. She was one of those who had the vision of the better pioneer and did so much for maintaining the ideals of the frontier.

National road.—The national road was built to satisfy political, strategic, and economic demands. In those early days the Atlantic Coast was the essential part of the country and the Mississippi Valley was in reality a vast, unabsorbed province. Then, too, by indomitable will, empire builders were urging their overladen horses through the mountains and beyond, and they deserved the aid of the Nation. The three natural routes through the mountain had been known to the wild life of the forest. Buffalos carrying 1,000 pounds of flesh and capable of covering 200 miles a day had been passing and repassing through the mountains, looking for fresh pastures and salt licks. They laid out by intuition the best routes through the mountains. These passed through the lowest cols and cleverly followed the divides where the soil dried quickest and there was least snow. There were three routes: (1) through northern New York, (2) through southern Virginia, and (3) through northwest Maryland and southwest Pennsylvania. The New York Central uses the first route today. The second route passed through Cumberland Gap and was later traced by Boone when he laid out the Wilderness Road. The third route passed up the Potomac, crossed the mountains, and led down to the Ohio and was the logical course for the national highway. Washington's road and Braddock's road were laid out along portions of it.

The national road in Ohio ran from Wheeling through St. Clairsville and Cambridge to Zanesville, much as Zane's Trace had done. Here instead of turning southwest with the Trace it continued west to Columbus and Springfield, and thence to Richmond, Indiana, and beyond. The fact that Cincinnati was so well served by the Ohio River was the determining factor which kept this road on its westward trend from Zanesville, thus ignoring the population center of the southwest. Perhaps the part of the road which was most important to Ohio was that portion without the State. When the road was completed across the mountains from Cumberland, Maryland, to Wheeling, West Virginia, its greatest mission was fulfilled in the crossing of the Alleghenies. In 1825 an appropriation was made to complete the road to Zanesville and make a survey for the additions that were to follow through the capitals of Ohio, Indiana, and Illinois. Unlike the situation in Pennsylvania where the road was laid out through important towns, here the contract called for a direct route through the capitals of the three states. Newark and Granville pleaded in vain to be participants in the commerce by having the road pass through their towns. The tendency

was thus for the establishment of new towns along its route and the hastening of the settlement of these rich plains. (Fig. 24, p. 94)

In 1850, the road had been graded as far as Vandalia, then the capital of Illinois. The road was an expensive matter but an immediate effect was the employment of large numbers of men and teams. These were the days when a man might have a good farm but be unable to realize cash for his work, and his employment on the road when not farming was a great benefit. The system of toll gates in Ohio, every ten miles, was to draw a revenue for the expensive maintenance.

Just as there was evolved a class of river men so a definite group of road men came into existence. Mail-coach drivers, express drivers, and wagoners passed and re-passed, bringing in tens of thousands of immigrants and great loads of freight. Convoys of twenty coaches or an equal number of creaking Conesta freighters would pass. In the paddock of the taverns 100 tired horses might be collected for the night. A simple hostelry might serve 70 guests at breakfast. The settlers traveling with faith and hope to the west were encouraged by the sight of great droves of cattle going to the markets. In the inns at night groups of men were brought together, aristocrats and lowly, fellows in common hardship. The road was a highway of democracy. Gradually as conditions improved, companies began maintaining fine express services and taverns became differentiated. This democratic aspect was lost. The wagoners with their "wagon boats" came to have taverns of their own. The fine mail coaches stopped at superior hostelries. But still the roads served as a life-giving artery. In these days of tourist travel in automobile, of long distance truck traffic, and of bus routes, the road is again taking on a through aspect which it had all but lost.

Tavern keeping became a business of no mean proportions. There was much that was picturesque about the tavern and tales are still told of the scenes in the great rest room about the fire. There was one custom which they all had in common. The innkeeper was keeper-of-the-poker, and none might poke the fire but him. Most of the hostelries were named after the original owner and came to have established reputations, good and bad. The Neil House, a famous hotel of Columbus, was opened as a post house in 1820 and was built of logs.

It was by the national road that the occasional president-elect from the trans-Alleghenian states passed out to Washington. The entire pass was a fete. The towns were bedecked and the procession was led by a Charioteer to the President. These were the days of Jackson and Harrison. Henry Clay, the champion of the road, Gen. Lafayette, Gen. Santa Anna, Jenny Lind, and P. T. Barnum were in their time all proud to take that grand tour of the day. It was the American Appian Way—the scene of triumphant processions. But for all this, it was a road built by the people and for the people—the commoner's highway.

THE CANALS

What has been previously said has pointed most directly to the need of better communication within the State. Ohio was still a vast wilderness at the beginning of the nineteenth century, for although there were 50,000 people within its boundaries, they were widely dispersed. There was little opportunity for industrial development as the market was almost purely local. Even agriculture was greatly hampered by having no outlet for its surplus. Canada offered a small market for farm products through the lake trade and New Orleans a somewhat greater market for river-borne traffic. This last city frequently was overstocked, especially when the falls of the Ohio were at high water and many large boats could pass. At such times a farmer having transported his produce to the river mouth was forced to sell at a loss or let it rot. Indeed much damage was done to flour, wheat, corn, and pork enroute due to the hot, humid climate of the Lower Mississippi. Thus New Orleans was a fluctuating and unsatisfactory market. There was still another dire need for better communication. The early settlements had been along the river bottoms at the south and north margins of the State, with a few people along the main watershed between the streams. These various settlements had people of diverse origins and political beliefs. Hence there was a demand on the part of statesmen for better communication between the isolated communities in order to consolidate the State politically.

New York began active work upon the Erie Canal in 1810. The eastern markets had long been coveted by the Ohioan and it was quickly seen that if canals were built to Lake Erie produce might travel on the water to New York City. Flour was worth \$3.50 a barrel in Cincinnati in 1821 and \$8.00 in New York. A canal, it was estimated, would permit a barrel of flour to be transported to New York for \$1.70 and the \$2.80 would be profit. Because of the low divides which existed between the streams of the glaciated section, the building of canals was relatively easy. Indeed there were five routes which might have been used. These were—

- (1) The Mahoning and Grand rivers
- (2) The Cuyahoga and Muskingum rivers (Tuscarawas branch)
- (3) The Black and Muskingum rivers (Killbuck branch)
- (4) The Scioto and Sandusky rivers
- (5) The Miami and Maumee rivers.

In order to get the support of the populace and not to slight certain sections, it was thought that three north-south canals must be built. For economy's sake this plan was compromised with the idea of a diagonal canal which would take in the southwest, central, and northeast

sections of the State which represented the most densely populated portions. The Miami, Scioto, Muskingum, and Cuyahoga rivers were to be utilized. However, it was discovered that the watershed between the Miami and Scioto was everywhere so high that it would be impossible to get a water supply for the canal as it passed over the divide. The Miami Valley was then excluded from the plan with the understanding that it was to have a canal of its own running due north to the Maumee. The Ohio Canal was to run from Cleveland up the Cuyahoga to the headwaters of the Tuscarawas, thence into the Muskingum, across to the Licking, so to the Scioto below Columbus, and down to Portsmouth. Twelve counties would be thus traversed. The Miami and Erie Canal ran from Cincinnati on the Ohio to Toledo on the Maumee. This touched fifteen counties. By 1833 the main part of the work was finished and the enthusiasm which attended the passage of the first boat bespoke of the hopes which the people of the State had placed in the waterways. At that day the State owned 400 miles of navigable waters in which there were 184 lift locks. By 1845 there were 800 miles of canals within the State.

Ohio canals in 1833

<i>Names of canals and branches</i>	<i>Length in miles</i>	<i>Number of lift locks</i>
Ohio Canal—Main Trunk-----	308.2	146
Tuscarawas Feeder-----	3.25	
Walhonding Feeder-----	1.4	
Granville Feeder-----	6.2	1
Muskingum Side Cut-----	2.7	3
Columbus Feeder-----	11.75	2
Ohio Canal total-----	333.50	152
Miami Canal-----	66.0	32
Hamilton Side Cut-----	.7	
Total—Miami Canal-----	66.7	32
Grand Total-----	400.20	184

Various branch canals and feeders were constructed, some by the State and some by private enterprises. The Warren County Canal extended from Lebanon to the Miami Canal, without a lock, a distance of 17 miles. The Cincinnati and Whitewater Canal ran west from Cincinnati to Wayne County, Indiana, and had a length of 90 miles. The Sandy and Beaver Canal was a tributary of the Ohio Canal and extended from Bolivar through Stark, Carroll, and Columbiana counties into Pennsylvania and was 73 miles long. At its summit it passed through a tunnel. A 12-mile branch ran up to Canton. Feeders of the Ohio Canal were constructed to reach Granville and Columbus. The Pennsylvania and Ohio Canal ran from Akron, through Ravenna, Warren,

Youngstown, and into Pennsylvania. The Walhonding Canal was a short "ditch" running from Brinkhaven to Coshocton. The Hocking Canal was 58 miles long. This ran from the Ohio Canal down the Hocking Valley through Carroll, Lancaster, Nelsonville, and Logan to Athens. The Muskingum Improvement was a canalization of that river so that steamboats could pass from Marietta to Dresden. In the construction of these waterways it was necessary to build large reservoirs and many smaller ponds—the whole making a most complicated system.

Ohio canals in 1850

Miami and Erie Canal.....	301.49 miles
Ohio Canal.....	512.26
Pennsylvania and Ohio Canal.....	76.00
Sandy and Beaver Canal (less 6 miles included in Ohio Canal)....	79.00
Whitewater Canal.....	32.00
	<hr/>
	1,000.75

The traffic on the canals became active as soon as they were opened. From the beginning in 1827 to just before the Civil War the tonnage increased constantly. Wheat, corn, coal, iron ore, pork, flour, bacon, lard, whiskey, and lumber were the principal commodities but much of the traffic was not of a through nature. The passage of the Ohio Canal over the Licking divide was difficult as there was inadequate water supply. The Miami and Erie Canal had smaller inherent difficulties but it was not completed until 1845. Part of the Cincinnati, Sandusky, and Cleveland Railroad had been built in 1837 and in 1848 the railway offered heavy competition by its through route from the lake to the river. Between 1850 and 1860 there were more miles of railway constructed within the State than in any decade since and by 1856 the canals had ceased to pay for their upkeep. The Civil War and the stagnation of industry which attended that period tolled the knell. The canals from that time deteriorated and one after another was abandoned.

Traffic of Ohio canals in the declining period

	1906	1889	1880
Ohio Canal and Branches.....	8,818 tons	129,398 tons	429,626 tons
Walhonding Canal.....		948	3,309
Hocking Canal.....		7,353	35,290
Miami and Erie Canal.....	75,234	969,477	751,360

The least tangible effects of the canals were perhaps the greatest in value. Strong ties were established between distant portions of the State and sectional feelings and local prides were lost. This has been

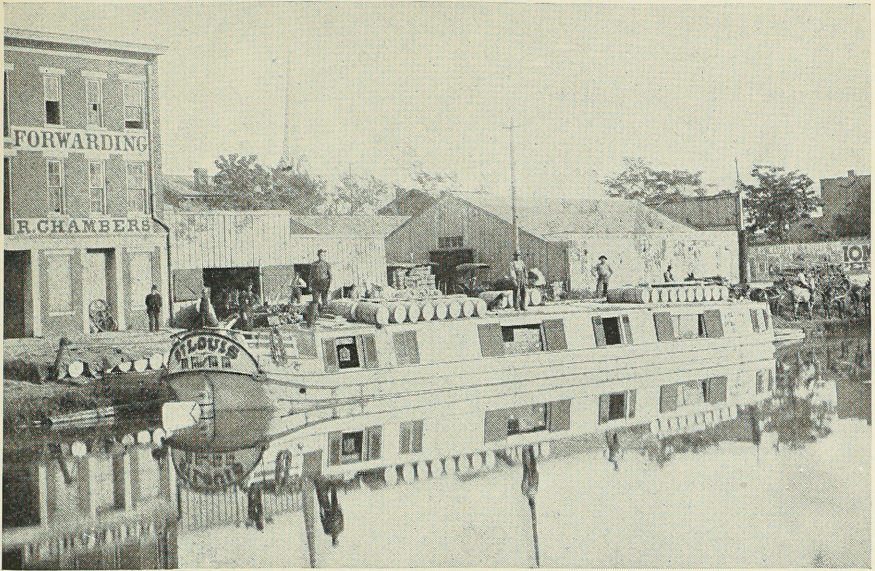
the greatest factor in making Ohio the excellent, well-organized unit that it is today. Also the canals were man-made streams of civilization along which immigrants came bringing with them the moral and intellectual advantages of the east and that strength that lies in numbers. In 1820 there were 581,434 people in Ohio; in 1860, 2,339,511. These were the forty years in which the canals were most active. It is true that the tide of immigration would have come had they not been built. Settlers had been coming on foot and in carts and were soon to come upon railways. But that the canals were a factor in hastening settlement may be seen in the growth which the cities immediately bordering them experienced.

Early Growth of the Canal Cities

	1820	1830	1857
Cincinnati	2,602	----	200,000
Cleveland	400	----	60,000
Dayton	1,139	----	16,000
Columbus	1,400	----	25,000
Chillicothe	2,416	----	10,000
Toledo	-----	500	14,000
Portsmouth	500	1,000	5,000
Hamilton	600	----	4,000
Newark	700	----	4,000
Akron	-----	700	4,000
Circleville	500	----	3,500

The canals were built at great sacrifice by a State with resources which were at the time relatively slight and as an undertaking they represent the finest energies of a sturdy pioneer people. They reacted for a time most favorably; they stimulated commerce and united the State politically. Also they raised the price of labor and caused a sudden advance in agriculture, mining, and manufacturing. Cities sprang up along the routes. Toledo and Cleveland as termini obtained a stimulus which they still feel. Cincinnati, already a large city, profited tremendously. Along the Miami Canal, Hamilton, Dayton, Troy, Piqua, St. Marys, Delphos, and Defiance sprang into prominence. The list for the Ohio and Erie Canal and its feeders is longer and includes Portsmouth, Waverly, Chillicothe, Circleville, Columbus, Lancaster, Logan, Athens, Newark, Zanesville, Canal Dover, Massillon, Canton, and Akron. It was during the two decades, from 1820 to 1840, that the states north of the Ohio and east of the Mississippi grew in population 360 per cent, and the Ohio canals together with the Erie Canal of New York State played no small part in this.

Land values along or near the canals increased proportionately. The farm products had access to markets, industry was stimulated, and important water power supplied. Also the importation of eastern



A—The Miami Canal at Dayton. This photograph was taken when the canals were in their heyday. This shipshape looking boat is tied up before a forwarding station or depot. (Courtesy of the Dayton Chamber of Commerce)



B—The Ohio Canal today in Tuscarawas County. In places the canals of yesterday are hardly visible. Elsewhere they form elongate frog ponds. (Photo by Stout)

manufactured articles was facilitated. Agricultural values and industrial possibilities of the canal counties and of those near the canal rose tremendously.

The beginning of traffic upon the canals had an immediate effect upon prices. The interior of Ohio had obtained much less for its grain than was being obtained at Sandusky. For example, flour was worth \$15.00 a barrel at Sandusky in 1817, whereas at Columbus or Chilli-cothe it was worth but \$6.00 or \$6.50. Wheat sold for 20 to 30 cents a bushel lower and corn 10 or more cents lower in the interior than along the lake. In turn the cost of condiments and cloth and other articles brought from the south or east was proportionately high. The farmer in the center of the State might drive 60 miles over bad roads to exchange his wheat at a low price for salt, glass, nails, tea, coffee, and sugar at an extremely high price. With the opening of the canals, wheat at Columbus sold at 50 to 75 cents per bushel more and for many miles on each side of the canal the influence was felt. Prices of imported commodities fell, thus in 1829 a bushel of wheat bought less than 6 pounds of sugar and in 1859 it bought over 15 pounds. Seven counties of the northwest, which had previously to 1848 had no facilities for reaching market, in that year exported some \$400,000 worth of goods. Besides the farm products in this region, lumber, staves, and ashes were sent on the waterways. Land values and the price of labor both increased.

This period was a significant one for industries. Perhaps the first industry affected was that essential manufacture, salt production. The salt previously obtained by canal from New York State notably decreased in quantity. Whereas in 1840 no salt was shipped from the Hocking Valley, in 1844 there were 9,416 barrels sent out by canal. The Muskingum Improvement increased its salt shipments from 1,705 barrels in 1840 to 19,042 in 1844. Coal mining was equally stimulated. On the Hocking the increase in production was from 31,981 bushels in 1841 to 118,004 bushels in 1844. The water power developed from the canal spillways was hardly less important to industry than the transportation. In 1839 such power was operating 207 pairs of 4½-foot millstones. Until very recently the power developed by water from the canals was a large factor in Ohio industry.

The industries of Ohio in 1840, 1850, and 1860 were along Lake Erie, the Ohio River, and the canals. The greatest developments were at the canal ports where these strips of water brought produce from the interior to the lake or river which in turn gave access to outside markets. The traffic of the Ohio was down stream, hence Cincinnati in the southwest corner of the State became the great canal and river town. The traffic on Lake Erie went east and so Cleveland, rather than Toledo, became the great canal-lake port.

IRON MANUFACTURE AND THE INFLUENCE OF THE LAKES

Iron manufacture in Ohio stands first among the industries of the State. Yet Ohio today does not mine iron ore nor produce coking coal except in a very small way. The basis of this great industry is one purely of geographical location.

Ohio once had fuel for blast furnaces in its forests which were in those early days converted into charcoal. Clearing the land for agriculture was the main cause of depletion of this fuel, and, with the exception of certain hilly regions less attractive to the farmer, charcoal as a fuel was not used for more than 30 years. Local coals were coked but coking coals were few and not of good grade. Indeed some coals were used raw. Ohio also had iron ores, mainly carbonates, but again this ore was lean, not present in large quantities, and totally unprepared to compete with Lake Superior hematite as soon as communication with that region was established. However these resources of fuel and ore were sufficient to create an iron industry in those days of difficult communication and local demand. This industry was the parent of the great iron and steel furnaces and the foundries and machine shops of the Mahoning Valley, the lake ports, and almost every other city in Ohio.

The first furnace was erected in 1804 in the Mahoning Valley. Early furnaces in this region operated with charcoal fuel and developed a blast through water power. Nodular clay iron-stone associated with the coal beds was the ore. Niles had a charcoal forge in 1809 where the first malleable iron in the State was made. Adams County had a blast furnace in 1811-12 where a limonite ore found in pockets in the limestone was used. A great stimulus was given when the extensive carbonates of the Hanging Rock region of Lawrence County were discovered. Union Furnace in the same county was in operation in 1827. Within 20 years the industry had spread to Scioto, Jackson, and Vinton counties. This region, which in 1825 was a wilderness, in 1869 had 38 charcoal furnaces producing 90,000 tons and 5 coal furnaces producing 15,000 tons annually. There have been erected and operated 102 charcoal furnaces in the Hanging Rock region extending from Union Furnace to central Kentucky. As with other early industries there was little concentration and furnaces were found in Mahoning, Trumbull, Adams, Summit, Licking, Lake, Cuyahoga, Lawrence, Scioto, Tuscarawas, Lorain, Huron, Muskingum, Hocking, Athens, Jackson, and Vinton counties.

In 1856 Lake Superior ore was introduced into Ohio. Even in the days of small development and expensive transportation these ores took the place of local ores because of their large percentage of iron, their purity, and the improvement in the character of the iron produced. For some time the Tuscarawas Valley, Hocking Valley, and Hanging Rock region of southern Ohio maintained themselves on local ores.

The last of these furnaces, the Jefferson, of Oak Hill, Jackson County, was shut down at the close of the World War, after nearly continuous operation since 1854.

The greatest of the iron manufacturing regions had early importance. This region lies along the line of cities from Youngstown to Cleveland and includes Niles, Warren, and Akron. The Ohio River region is essentially a continuation of this manufacturing area, and includes Wellsville, Steubenville, Martins Ferry, and Bellaire. The great advantage which these cities possess is their proximity to the Connellsville coke region of Pennsylvania and their easy access to the lake ports through the Ohio and Mahoning Valley and across the glacial plains. This does not mean that local coals were not used, as the Briar Hill block coal was used by mixing it with Connellsville coke. Also local ores were used, frequently mixed with foreign ores, and from June, 1879, to June, 1880, the ores in the six principal works in the Mahoning Valley had the following sources:

	<i>Long tons</i>
Lake Superior and Canada.....	229,427
Pennsylvania and New York.....	28,219
Native Ohio ores.....	14,802

There were used at one time in southern Ohio iron ores from the Ozark Highlands of Missouri which came by river.

The iron and steel industries of today depend upon Lake Superior ore. This is made possible by the magnificent highway—the Great Lakes. Originally ore was brought in sailing vessels to St. Marys River at the outlet of Lake Superior where it was portaged overland to Lake Huron, and so carried in ships to Lake Erie ports. A 12-foot canal was built across this portage in 1855 and Ohio manufacturers, especially during the Civil War, responded actively to this opportunity. There are now five canals between the two lakes and a passage 21 feet deep is maintained. In 1853 there were three or four schooners of 15 to 20 tons burden and two small steamships operating on Lake Superior. Today there are hundreds of huge barges plying between the ore fields and Ohio ports. Between 1905 and 1907, 26 freighters of 13,000 to 14,000 tons each were launched. Toledo, Lorain, and Cleveland have played an important part in the shipbuilding enterprise. At first these ports manufactured wooden boats but now are great centers of steel shipbuilding. In 1907 Lorain built 9 vessels which was equalled on the Great Lakes only by Ecorse, Michigan. Cleveland and Toledo in the same year each built 3 vessels. In 1886 there were but 6 steel vessels on the lake but in 1920 great steel fleets moved 79,282,496 tons through the St. Marys canals, of which 56,780,498 tons were iron ore and 14,156,256 tons were coal. Over 80 per cent of this ore was destined for Lake Erie ports; Ashtabula received about 20 per cent, Conneaut 17 per cent, and Cleveland 15 per cent. Of the returning coal which

passes through the canal, Toledo ships 23 per cent, Ashtabula 20 per cent, Cleveland 18 per cent, and Lorain 12 per cent.

These steel barges are of great length and have large storage capacity. As compared with the ocean, the relatively quiet waters of the lake permit the operation of these huge barges which are of light construction and in which a minimum of space is given over to coal bunkers, thus constituting one of the cheapest carriers of bulk freight in the world. In 1920 one ship passed through the canal with a burden of 15,581 tons. The result is that ore which would cost \$6.40 to send by rail comes on the lakes for \$1.10. Rather than have the boats return empty coal is carried back at as low a rate as \$0.50 a ton.

Ohio has two types of lake ports—the receiving and manufacturing ports and the receiving and distributing ports. In the first class are Cleveland, Toledo, and Lorain. Ashtabula and Conneaut are examples of ports which are merely unloading and distributing points. Ashtabula which but for this commerce would be only a village is the largest ore and coal port in America and probably in the world. In 1919 there was received here 8,377,277 gross tons of ore. Cleveland in the same year received 7,466,291 tons. The nearest competitors were Buffalo and South Chicago, each of which received about half the tonnage of Ashtabula, which has superseded all other cities because of its excellent dockage facilities and because of the level plain across which the railways run to the Mahoning Valley.

Iron ore received at Ohio ports, 1915–1919, in gross tons

Port	1915	1916	1917	1918	1919
Toledo.....	1,158,374	2,035,160	2,445,602	2,608,497	1,536,437
Huron.....	695,865	1,324,112	1,631,395	1,620,712	1,134,104
Lorain.....	3,517,258	4,613,929	3,831,244	3,494,370	3,379,421
Cleveland.....	7,504,697	10,669,745	9,077,161	9,681,882	7,466,921
Fairport.....	2,001,103	2,580,647	2,311,179	1,853,465	1,952,635
Ashtabula.....	7,813,101	11,474,268	10,251,304	11,001,574	8,377,277
Conneaut.....	8,573,509	9,588,341	8,729,754	6,650,898	7,056,882

The iron and steel industries have been an important factor in every great city of the State and with many of the lesser ones. An exception is Cincinnati. The manufacturing has taken the form of blast furnaces, steel furnaces, foundries, and machine shops. There are 14 cities in Ohio which have important iron furnaces, 19 that have large steel mills, 21 maintaining important machine shops, and 23 where foundries form industries significantly large. Without iron and steel products Youngstown, Warren, and Steubenville would be mere villages. Cleveland and Toledo owe much to these industries and Niles, Leetonia, Ironton, Columbus, Middletown, Massillon, and Mingo Junction have all been profoundly affected. Toledo, Cleveland, Ashtabula, Conneaut,

and Lorain have huge docks for unloading the ore and loading coal and of these the last three were created entirely for this traffic. Lorain in 1910 unloaded ore which amounted to 97.5 per cent of the commerce in that town during the year.

THE RAILWAYS

Ohio in spite of her ultra-montane position was one of the first states to take up railway construction. In 1832, when there were but 229 miles of railroads operating in the United States, a charter was granted to construct a railroad from Sandusky to Dayton, a distance of 156 miles. Sixteen miles of this road were completed in 1839, which is now part of the Big Four System. In 1832, the Kalamazoo and Erie was projected and was completed in 1836 from Toledo to Adrian, Michigan, thus being the first railway in the State to operate. Made of oak stringers parallel to the tracks and covered with strap iron it was at first operated by horse power. The succeeding year saw steam engines in operation which carried passengers at 10 miles an hour and freight at half that speed.

The real period of construction began with 1848 when 211 miles of the Cincinnati and Erie were completed. In 1851 the Cleveland, Columbus, and Cincinnati finished 262 miles of road. The year 1852 saw the opening of the Cleveland and Pittsburgh (now part of the Pennsylvania System) and five years later the Marietta and Cincinnati (Baltimore and Ohio) was completed.

The early railroads were built with the idea of reaching those parts of the country not touched by the canals. An exception were the roads in the Miami Valley. Dependence upon the waterways is to be seen in that either one or both terminals were on a water route. It was soon discovered that the railroads could parallel the canals and compete with them. They profited hugely by the canals for they found cities, industries, and markets already established and to these they offered more rapid service and a service all the year around.

In three-fourths of the State railroad building was a comparatively easy matter. The level plains, the supplies of gravel for ballast, and the plenteous supply of tie and bridge timber led to rapid development. In the hilly portions certain corridor valleys, formed by pre-glacial streams and evened off by the outwash of the ice, created natural roadbeds. The hilly country back from the valleys developed railways mainly because of the rich coal resources. By the Civil War, most of the trunk lines of today had been laid out. In 1900 about 14,000 miles of railroads existed and Columbus, the natural and political center of the State, became the great rail center for it is the crossroads of the routes between Cincinnati and Cleveland and Pittsburgh and Indianapolis. The first rail to reach Columbus was in 1850, when the city was

connected with Xenia. In one day in May, 1922, more than 10,000 freight cars passed through Columbus yards.

The immediate effect of the railroads was to double the price of flour, treble the price of pork, and quadruple that of corn. Hardly later, mines and quarries took on new aspects. Much of the coal country had been too hilly for canals, the principal exception being the Muskingum and Hocking valleys. So bulky a product as coal awaited the coming of the railroads before development. Iron ore and salt tonnage likewise increased. The Cleveland and Pittsburgh (now the Pennsylvania) was constructed to get the coal of the Ohio Valley. The Baltimore and Ohio in the Cambridge field and between New Philadelphia and Wheeling; the Wheeling and Lake Erie in Tuscarawas and Belmont counties; the Cleveland, Lorain, and Wheeling; the Hocking Valley; the Toledo and Ohio Central; and the Kanawha and Michigan were constructed largely for the coal traffic. The railroads themselves did not generally use coal until 1870 for previously the engines were wood burning.

Between 1840 and 1850, 3000 miles of railways were surveyed and in the succeeding decade Ohio passed through its greatest period of construction. Between 1850 and 1860 Ohio gained 98 per cent in value of industrial products and one of the chief causes was that by 1861 this State had more miles of railroads than any other State. Previous to 1851, 97 per cent of the beef went down stream and 2 per cent by the lakes. Similar figures held true for corn, flour, lard, pork, and bacon. By the end of the Civil War this was changed. While at first much of it traveled part way by the Erie Canal of New York, congestion there caused the construction of through rail routes to the coast. A revival of river traffic seemed likely with the completion of the Portland Canal around the Falls of the Ohio at Louisville but for many reasons the Ohio was doomed to defeat. Today the river is canalized by an elaborate system of dams and locks but the observer on the shores of the river cannot but notice that on the Chesapeake and Ohio Railway, which though on the south side of the river serves Ohio also, long trains are thundering up and down the valley while the freight packet or barge on the river is a rare sight.

Ohio is more truly the gateway between the east and the west than any other State. The great passenger systems which cross the State from east to west are New York Central, Baltimore and Ohio, Pennsylvania System (Fort Wayne Route), Erie, Pennsylvania (Panhandle Route), and Baltimore and Ohio Southwestern.

The Big Four runs diagonally across the State from Cleveland through Columbus to Cincinnati whereas the Cincinnati, Hamilton, and Dayton crosses the west side from Cincinnati to Toledo.

Important coal routes are New York Central (Lake Shore and Michigan Central), Pennsylvania System, Baltimore and Ohio (Cleve-

land, Lorain, and Wheeling), Toledo and Ohio Central and Kanawha and Michigan, Hocking Valley, Wheeling and Lake Erie, and Norfolk and Western (handling West Virginia coal).

Important iron routes are Pennsylvania System, Baltimore and Ohio, Erie, Cleveland, Lorain and Wheeling, and Wheeling and Lake Erie.

CLAY INDUSTRIES

Ohio holds first place among the states in the value of clay products and the industry is second only to iron and steel. Among the factors which control the location of ceramic industries, nearness to raw materials stands paramount, except in the manufacture of certain fine potteries. Most plants are immediately at the pit. There are innumerable places where common clay, fire clay, and shales may be obtained. The factors, therefore, which have determined the actual situation of the yards are raw materials, nearness to coal, rail communication, and nearness to proper markets. Fortunately the best deposits of clays and coal are associated. The shales are associated with or are not far distant from the coal. The many common brick and drain tile yards in the west of the State are small and prosper mainly because of nearness to markets. They prosper only so long as the *local* population supplies a demand; after that they fall into disuse. The amount invested in such plants is, of course, small.

The first brick made in Ohio was burned at Marietta in 1788 to build chimneys for Fort Martius. Earthen-ware pottery was made in Cincinnati in 1799 and was probably among the first industries of the place. Stoneware was burned at Zanesville in 1808. Yellow ware became an important industry at East Liverpool after 1840 though today this has developed into a huge white ware industry. At the same place, door knobs were manufactured in 1844 and this in turn has evolved into a large electric porcelain industry. Sewer pipe was made at Toronto and Akron in 1853 and became extensive in 1868 with the introduction of the steam press.

The East Liverpool district began with the making of stoneware and gradually extended to the manufacture of smoking pipes, bottles, marbles, and chemical stoneware. Today high-grade white ware and electrical porcelain are important products. The local clays are not adapted for these finer products and the clays for the white ware are imported from Georgia and Florida (kaolin), Maine and Canada (feldspar), Kentucky and Tennessee (ball clay), and Illinois and Pennsylvania (flint). This is an example of the importance of an established reputation and is not based on geographic conditions. Art pottery began in Cincinnati in a small way in 1875 through a woman's china painting club. This led to the establishment of the Rookwood Pottery in 1880 which today produces some of the finest pottery in the world. It is interesting

to note that the clays used here for white ware are all foreign to the State though the red ware is burnt of Ohio Valley alluvium.

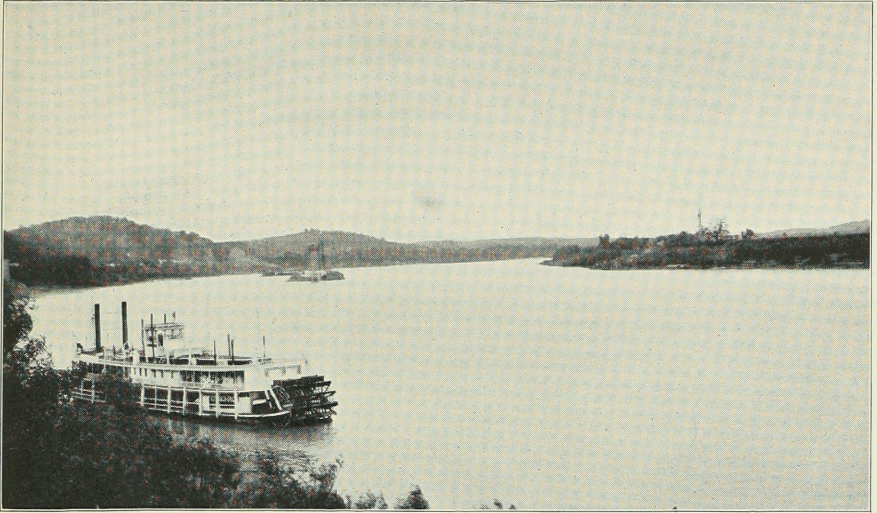
Though fire brick was first made in East Liverpool in 1846, the industry began in a big way at Sciotoville in 1863 and at Dover in 1870. Paving brick was made in the early eighties and the industry has largely centered around Cleveland, Zanesville, and Portsmouth.

Today the great clay producing regions of the State are widely scattered over the eastern part. East Liverpool, Empire, and Toronto form an area famous for its sewer pipe and at East Liverpool the amount of white ware produced is large. Zanesville, Roseville, Crooksville, and Shawnee are some of the greatest clay working centers in the world. Paving brick, yellow ware, and white ware, fine tiles for interior work, and art pottery are among the products. Dennison and Uhrichsville are characterized by their huge sewer pipe production. Sewer pipe and paving brick are made in large quantities at Cleveland, Akron, and Portsmouth.

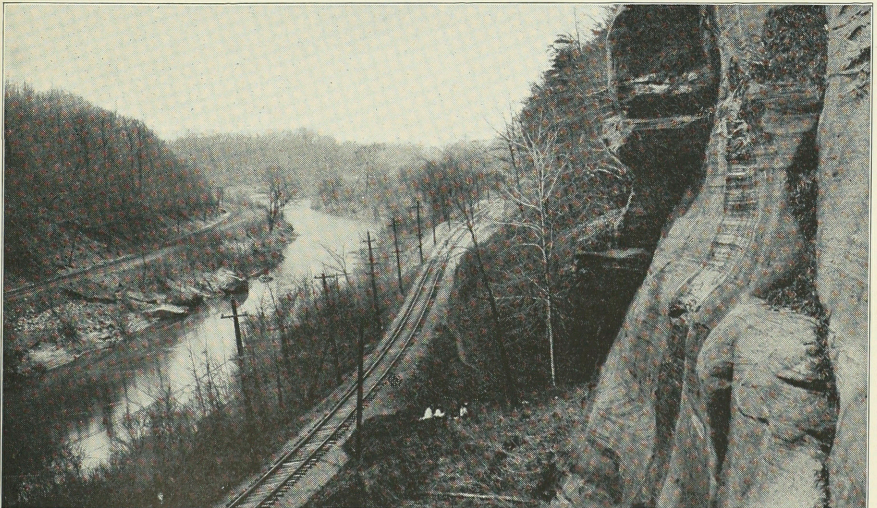
RECENT ASPECTS OF TRANSPORTATION (SINCE 1890)

Railways and lake boats have been developed to a high stage of efficiency. Ohio is the pathway between the Great Middle West and the eastern coast. The New York Central, the Erie, the Pennsylvania, and the Baltimore and Ohio railways have all developed magnificent trunk lines which have brought about industrial development. Not only has this meant the growth of Ohio industries which were dependent upon the natural resources in or within easy access of the State but it also has meant the locating of many industries which are not dependent upon the local natural resources. Of these the rubber industry at Akron stands foremost. The center of the population of the country has been in or about Ohio for a century. For 60 years Ohio has had rail communication with all the eastern states which are important for their density of population, their manufactures, and their natural resources. The boats carrying iron ore and coal are examples of the most efficient carriers in the world. In addition to this the lake ports have taken advantage of the waterway and ship large amounts of general merchandise in the boats. The Ohio River though it has lost prestige as a carrier may with its recent improvements and the increase in population come once again into its own.

But the significant improvement of this century has been by none of these three methods. Since 1890 the electric interurban has been of large importance and in the six years of 1890 to 1895 inclusive there were 110 companies incorporated for operating interurban railways. Though at first these centered chiefly around Cleveland, Dayton, Youngstown, Toledo, Cincinnati, and Columbus have become centers also. The importance of the electric railway was not as great to the



A—The Ohio River at Sciotoville. This scene shows how the river may swing against one line of hills while on the opposite side there is a flood plain on which fine crops may be grown. The boat in the foreground is typical for this stream. (Photo by Stout)



B—The gorge of the Licking River. This is an illustration of how a narrow valley may guide routes of transportation. On one side is a traction line and on the other a steam road. Formerly the river itself was used for a canal. (Photo by Stout)

urban centers as to the rural districts. It put regions otherwise purely agricultural in contact with cities. The frequent service made possible by electricity put within reach of large numbers the commercial advantages of the urban centers and as well it permitted the farmer to find employment in the towns while maintaining a small farm. The city dweller in turn was able to avail himself of the sanitary and economic advantages of the country. By the number of interurbans which are discontinued it would appear that they have passed their height of prosperity.

This last century has seen great advances in the improvement of roads but the importance of good roads to the farmer needs not be stressed here. With this improvement came the automobile and it is a poor farmer who does not today own a machine and a run of 30 miles—not to a crossroads hamlet, but to a city—is a matter of slight consequence. Many towns have bus line connections. The use of trucks by the farmer, the commission merchant, and the milk companies is fast altering the economies of all regions reached by good roads.

The telephones, rural free delivery, better roads, and automobiles have together militated against the isolation. While it has tended to break down the social community which in isolated regions found expression in the quilting "bees," the dance in the farm house, and in meetings in the little church in the open country, it has enlarged the social outlook. The farmer may know less of his neighbors but he knows more of the city or town. The village church has taken the place of the country church. The full-time, better-paid pastor has replaced the preacher-farmer who received little or no pay. The Presbyterian Church made a survey (1910) of an area in which the relation of good roads, decrease of rural population, and church attendance is striking. The better the roads, the better the church attendance. This is partly because of the ease of getting to church and partly because of the prosperity and density of the population which goes with good roads.

<i>Townships</i>	<i>Miles of improved roads</i>	<i>Change in population 1900-1910</i>	<i>Church membership per township</i>	<i>Membership in church</i>
22 with poorest roads.....	0	—11.4 per cent	305	55.9
23 with poor roads.....	44	—67	346	56
22 with good roads.....	174	0.02	375	63.1
23 with best roads.....	490	6	801	100.3

Perhaps the most significant social effect of better roads is in the schools. The small country school administered by the local board

and by an untrained school teacher is now supplanted in the more prosperous districts by the large centralized school, competently taught. Pupils are picked up in busses and carried considerable distances to the school and returned at night. Schools are now the results of the combined resources of a township and they are modern in every respect.

The last word in communication is radio. Weather reports, frost warnings, and market reports are being broadcasted. Musical and lecture programs are within the reach of all. West Sister Island, the most isolated part of the entire State, is a bit of land lying 9 miles out in Lake Erie from Port Clinton. It is without telephonic communication, has no mail service, and ships seldom land there. Captain Chauncey Fitzmorris and his sister have lived there in loneliness for 15 years, maintaining the light. On April 1, 1922, the captain visited the mainland for the first time since early November and to do this he rowed 9 miles in an open boat. The captain and his sister now receive regularly by radio news of the day, reports of the ball games, and fads and fashions as well as listening to nightly concerts and lectures.

Bibliography on Transportation and the Development of Industries

Much of the material for the last two chapters has been gained from the articles of the Ohio State Archaeological and Historical Society which are too numerous to mention here. "The History of Ohio Canals" (parts 1 and 3), by C. C. Huntington, published by this society in 1905, was the basis for the section on canals. Free use was made of "Transportation and Industrial Development in the Middle West" by W. F. Gephart, as it will long be an authority on the early economic history of the State (Studies in Hist. Econ. and Public Law, Columbia University, Vol. XXXV, 273 pp. with bibliography, 1909). "The Rise of Manufactures in the Miami Country" by F. P. Goodwin (Amer Hist. Rev., Vol. XII, 1906-7, p. 761 et seq.), and "The Paths of Inland Commerce" by A. B. Hulbert (1920) were particularly suggestive. Of the many books of recollections, "Recollections of Life in Ohio 1813-1840," by William Cooper Howells, is especially interesting.

CHAPTER VI

SETTLEMENT AND DEVELOPMENT

THE IMPORTANCE OF POSITION

The greatest single geographic factor in the quantity and quality of Ohio's greatness is the matter of position. The Great Lakes and Canadian boundaries on the north and the Allegheny Mountains on the south have crowded lines of western expansion through Pennsylvania and New York State into Ohio. The Ohio River with its southwest trend has acted as a boundary and limitation as have the Great Lakes. Thus Ohio represents the flare of a funnel. Once the early settler had passed through the mountains a plain of great fertility and many streams lay before him. There was no need to go farther. He unloaded his cart, unharnessed his tired horses, and with an axe built a home. Today the manufacturer, seeking factory sites west of the crowded coast region, finds in Ohio trunk lines from the east passing through the State and then radiating over the entire valley of the Mississippi. In the great density of population based upon agricultural prosperity he finds sufficient labor. The agricultural settlement is accomplished; the industrial settlement is in full swing. The importance of position is as fundamental in the economies of general manufacturing plants today as it was in the early history of the State.

Ohio is likewise in the path of north-south travel. The nearness of approach of two great drainage systems, the Great Lakes-St. Lawrence and the Ohio-Mississippi, coupled with the fact that their tributaries flow from a common divide, which has been made less distinct by glaciation, gave the region great significance to the French who dreamed of an interior empire extending from Quebec to New Orleans. Ohio was the crossroads of French and English expansion. The Indians being driven out of Canada and New York by white aggression settled temporarily in Ohio and added to the strife. Not only were they on the defensive but they were pitted against the white man by first one side and then the other.

Today there is another sort of north-south travel. To satisfy the arts of peace, iron ore is brought on the Great Lakes to Lake Erie ports. To the south and southeast lie the greatest coking coal fields of the country. In turn the Great Lakes have created a huge market in the northwest for Ohio coals. The valleys connecting the coke regions with the lake ports hold some of the greatest iron and steel districts in the world, as the Mahoning Valley. It is on the basis of this trade, iron ore and coal, that the idea of canalization of the Scioto and San-

dusky rivers has been born. Here are two bulky resources passing and repassing through the State which might be handled on the slack water of two rivers connected across a low divide by a few miles of canal.

Thus in considering the factors which have played parts in the growth of Ohio this external matter of situation in contrast to the conditions and resources of site must never be disregarded. Its mark has been made in every chapter of Ohio's history.

CONDITIONS OF INDIAN LIFE

Many of the Indian tribes which the white man found in Ohio were tribes which he had pushed before him in his relentless aggression. When the first settlements were being made, Miamis, Shawnees, Delawares, and Ottawas of Alonquin linguistics and the Wyandots and Mingoes of Iroquoian linguistics were the principal tribes. A few Senecas were to be found in the north and the Valley of the Tuscarawas held some Iroquois. It is difficult to definitely locate their villages and hunting grounds.

The Miami Indians were located near the portage of the Maumee and the Wabash rivers. This was a region which "abounded at all times, especially in spring and fall, with game without end." Certain clans extended from the Wabash to the upper valley of the Miami and Little Miami rivers, having a fort near the present town of Piqua. Small detached groups of Cherokees were in Ross County and there were Chippewas in the Western Reserve. On the Maumee, were located Kickapoos, Pottawatomies, Ottawas, Chippewas, and bands of northern Indians. The Delawares were scattered among the Senecas, Shawnees, and Wyandots. The Shawnees were along the Ohio, Muskingum, and Scioto rivers. The Wyandots or Hurons, driven from the St. Lawrence across Canada to the northwest and back again, settled in large numbers between the Sandusky and Scioto rivers. The territory east of the Muskingum together with the country on the upper Ohio and Allegheny rivers was held by the Senecas, while certain bands of Hurons resided along the marshy shore of Lake Erie near Sandusky. The Indians were semi-nomadic and the villages were frequently mixed in their stock. The western part of the State, all of Indiana, and part of Illinois were held by the Miamis before the coming of the white man. The rest of the tribes were new to Ohio; Delawares from the Delaware and Susquehanna valleys and Mingoes from New York had migrated before the pressure of settlement. Ohio was the natural focus because, then as now, it was the crossroads of north-south and east-west travel.

The Indians soon adapted themselves to their environment. Ohio in the last part of the 18th century was supporting 15,000 semi-nomadic Indians who lived by fishing, hunting, and farming. The summer season was spent in tilling the land. The squaw did the tilling while

the warrior prepared himself for battle and raided his neighbors or the white settlements. Large areas of land were put into corn though the land was not cleared but the trees were "ringed" and so permitted to die. It was at this season that the tribes assembled in large villages and held their councils. Villages were located along streams for the water supply and were often near rapids because of the better fishing. Also the rivers served as highways for canoes. The Indian trails did not follow the water courses to any great extent but crossed the country ignoring divides and rivers.

In the winter the Indians went into the hills. Generally they broke up into family groups and made rough temporary shelters not deserving the name of villages. The men then hunted and trapped. The best conditions for hunting were found where there was a deep snow with a crust in which the animals could move but slowly. Also the snow permitted the Indian to move about with little noise. Winters without snow led to almost famine conditions. The buffalo, bear, and deer in particular were hunted, for a single kill meant a large quantity of meat and the valuable hide. All the small animals as the mink, beaver, raccoon, opossum, turkey, and pigeon were sought. Salt springs in the hills were rendezvous of the animals and there the Indian was wont to stalk his game. Also the Indian made salt in crude earthen "pans." Maple sirup was made by the squaws in the spring of the year. This later was mixed with bear's grease and green corn and preserved in a hide.

The fact that the hill country did not have permanent villages aided the precarious and difficult advance of the white man who approached the State from that side. Indeed the Ohio River Valley which might have been thought an excellent location for villages was almost devoid of them. An exception was Shawneetown near where Portsmouth is now. The Ohio Valley was a border between the northern and southern tribes, and villages erected there by either group would have been the object of ferocious attacks. Except for the occasional hunting parties this great artery was left free for the advance of the white man. Game became critically scarce after 1800 though the Indians returned to the hills in numbers to hunt in the southeast until 1812. Parties returned to the region about Franklinton (Columbus) as late as 1820. In 1830 the United States Government passed an act providing for the removal of tribes of Ohio and adjacent regions to west of the Mississippi. The era of the white man had commenced.

EARLY SETTLEMENTS AND THEIR SETTLERS

The first white people to seek out the Ohio territory were those trappers and traders of French and English origin who lived essentially as the Indians and who left even less record of their occupancy. Some

of them married the white captives of the Indians and set up "tomahawk claims." They, for the most part, moved on as soon as they heard the sound of an axe. These were followed by a restless, daring lot who made little clearings but who felt crowded if a neighbor moved to within five miles of their primitive establishments. After these came the sturdy pioneers who appreciated the opportunities before them and, undaunted by hardships, fought the wilderness and made Ohio their home.

The distribution of the early settlements was not wholly due to physical causes. The Government apportioned out areas to be settled. The matter is complex. The first settlement, Marietta, in 1788, was in a grant made to the New England Ohio Company at the junction of the Muskingum and Ohio rivers. Clearings were made in the Valley of the Muskingum and settlements even reached into the Hocking. The land on each side of the valleys was hilly and in those days suitable only for hunting. Hence there was slight opportunity for expansion by the people of New England who settled here.

The Symmes Purchase about the mouths of the Miami and Little Miami proved more fortunate in the amount and fertility of valley bottom that might be cleared. This region was granted to John Clive Symmes of New Jersey in 1788. At first it was on the pathway between the hostile Indians of Ohio and the Kentucky settlements, and Symmes colony became known as the "Miami Slaughter House." But after Wayne's victory in 1794 the same valleys which had proved pathways for the Indians, the Miami and the Licking of Kentucky, proved economic tributaries to the prosperity of the settlements and the future city of Cincinnati.

Of the many states which lay claim to the Northwest Territory but two, Connecticut and Virginia, were able to maintain it. An early tract to be entered was the Western Reserve of Connecticut in northeast Ohio. In 1793 the State of Connecticut turned over to a private company 3,800,000 acres. New Englanders who came by the lake route settled the country and gave it a stamp which it bears today in more ways than one. A tract of 4,204,800 acres, lying between the Scioto and the Little Miami rivers, was ceded by Virginia to her soldiers. This was parceled out in large plantations. Ideals of Virginian opulence of agricultural life and the breeding of horses were two characteristics of this early settlement. Much of the remainder of the State was sold by Congress to any one who applied. There were a number of minor grants of land, some of the more interesting of which were the Refugee Tract given to Canadians who assisted the United States during the Revolution, the Salt Sections which were lands about salt licks and springs reserved against monopoly, and the College Lands of which one tract went to Ohio University at Athens and one to Miami University at Oxford.

The first considerable concentrations of population were in the Muskingum, Miami, and Scioto valleys. Generally the larger settlements were on the rich and level bottom lands of the rivers. Also the rivers served first as a pathway for canoes and then for the barges which went down stream.

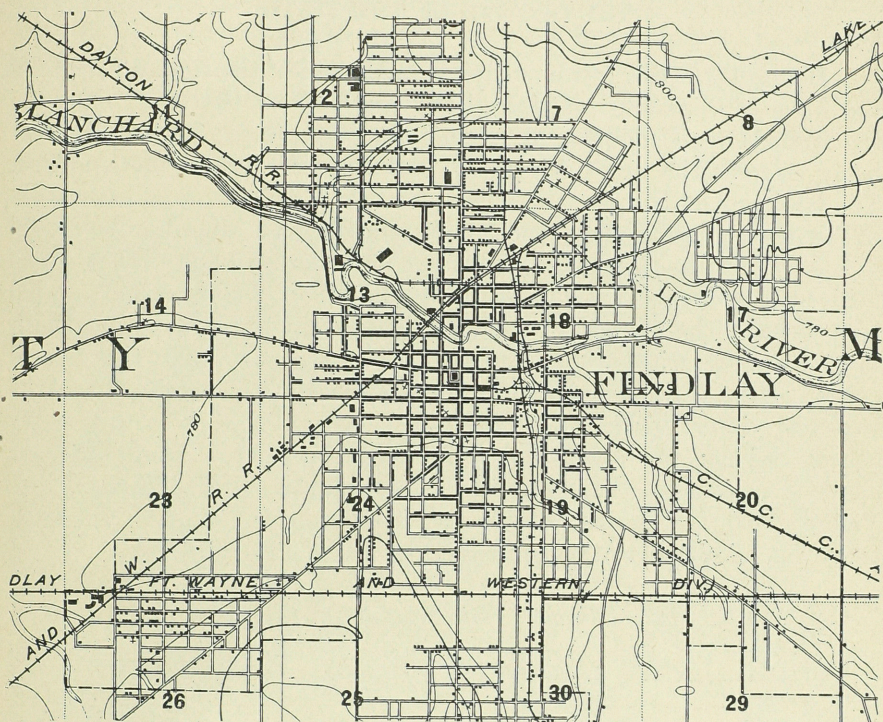


Fig. 25—Findlay; a Typical Farming Center of the Plains. (U. S. G. S. map. Scale about an inch to the mile. Contour interval 20 feet.)

The "back bone" or watershed counties were settled by Pennsylvania Dutch. They came from Lancaster, Bucks, York, and Washington counties, Pennsylvania, which were all great wheat producers. This is a partial explanation of the great wheat output by the thrifty farmers of Columbiana, Stark, Wayne, and Richland counties. It was this same stock that settled (New) Lancaster. Monroe, Tuscarawas, and Holmes counties were cleared by colonies of Swiss and it is there that Ohio's Sweitzer cheese is made today. The Germans who settled in the Miami Valley have been in no small degree responsible for the thrift with which its wonderful resources have been exploited. Southeastern Ohio naturally drew most strongly on Virginia. Gallipolis in Gallia County, as the name suggests, was settled by French. It was an unfortunate colony and did not hold together. The effect of Zane's Trace and the National Highway upon settlement is easily discernible. It became the great route for the

immigrant procession. Thousands of wagons brought settlers and their impedimenta into the very heart of the rich territory. The new line of settlements crossed at right angles those of the river valleys and brought into touch southern settlements with those of the watersheds. The State was solidified.

THE GROWTH OF THE STATE

Before 1776 Ohio was in complete possession of the Indian. By 1830 the wave of migration had forced the Indian from the land. In 1785 the Indians were complaining against the white men; the woods were being cleared; the game driven off; and the salt springs monopolized. The land proved to be a veritable Garden of Eden as far as luxuriance of plant growth was concerned. In the Scioto and Miami valleys corn yielded as high as 90 bushels to the acre and commonly 50 bushels. The fields and gardens produced almost beyond belief. The woods abounded in game and the stories of the large fishes from the streams one hesitates to relate without further substantiation. By 1800, the second census of the United States, 45,365 souls lived in the territory and by two years later this had increased to 60,000. There were four main concentrations: one along the Ohio River in what is now Jefferson County, a second at the mouth of the Muskingum, a third in the Scioto Valley about Chillicothe, and lastly, in Hamilton County. In 1803, Ohio was admitted to the Union. (Fig. 28, p. 123)

Population of Ohio from 1800 to 1920

1920.....	5,759,394	1850.....	1,980,329
1910.....	4,767,121	1840.....	1,519,467
1900.....	4,157,545	1830.....	937,903
1890.....	3,672,329	1820.....	581,434
1880.....	3,198,062	1810.....	230,760
1870.....	2,665,260	1800.....	45,365
1860.....	2,339,511		

By 1810 Ohio was 13th in population, 15th in the value of domestic exports, and 16th in manufactures. The State with 230,760 people had increased over 400 per cent in the decade. The Miami Valley was in no small way responsible for this. The region tributary to Cincinnati held 27.5 per cent of the population. The city itself had only 2,540 people. Zane's Trace had opened up new territory, and Belmont, Muskingum, and Fairfield counties formed new centers of concentration. The next two decades showed an increase of over 350,000 each; 1811 saw 236 wagons with nearly 2,000 people pass through Pittsburgh for Ohio. The War of 1812 and the hard winter of 1816-17 turned large numbers west. The decade of 1820-1830 was the period of the development of the Western Reserve and the "back bone" counties.

By 1840 the population was well distributed over the State with the exception of the black swamp lands of the northwest. The population which had hitherto been almost entirely rural now began to concentrate in cities. Urban and industrial Ohio had its birth in this period. There were 1,519,467 people in the State, 272,579 of whom were dependent on agriculture, 66,265 were connected with manufacturing, 19,201 were engaged in commerce, 3,323 in navigation, 5,663 were professional men, and mining employed but 704 men.

An urban center today consists of at least 2,500 people. It would be safer to consider an urban center in 1840 as having 1,000 people or more. There were eleven cities in Ohio in 1840 in this class.

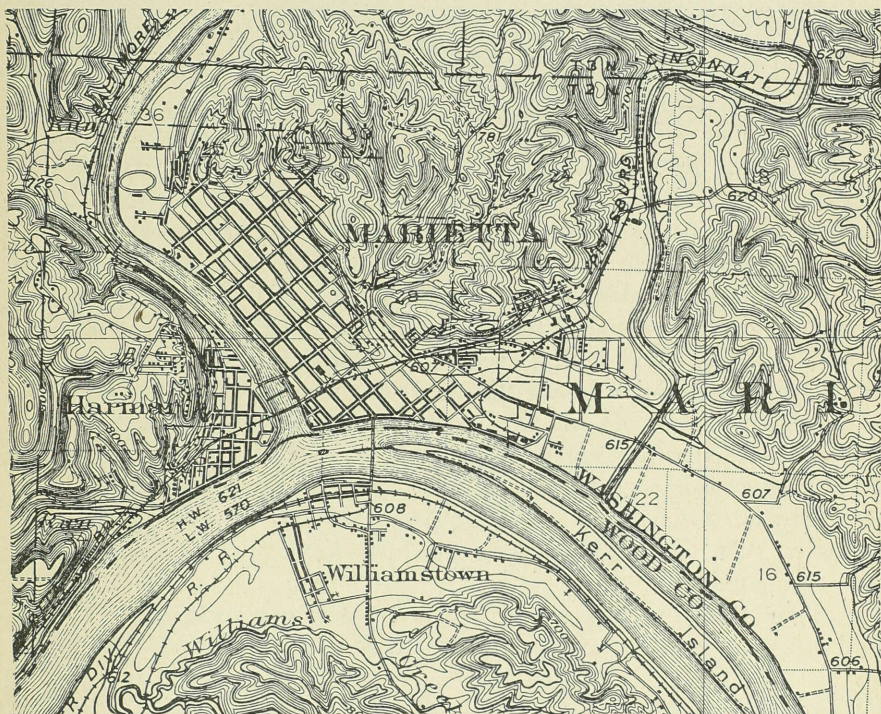


Fig. 26—Marietta; a Typical River Town. (U. S. G. S. map. Scale about an inch to the mile. Contour interval 20 feet.)

Cities in Ohio in 1840

	<i>Total population</i>	<i>Population engaged in manufacture</i>
Cincinnati.....	46,388	10,287
Cleveland.....	6,071	533
Columbus.....	6,048	726
Dayton.....	6,067	810
Xenia.....	4,913	207
Circleville.....	2,326	---
Springfield.....	2,062	251
Gallipolis.....	1,413	131
Chillicothe.....	1,377	20
Toledo.....	1,222	114
Urbana.....	1,070	187

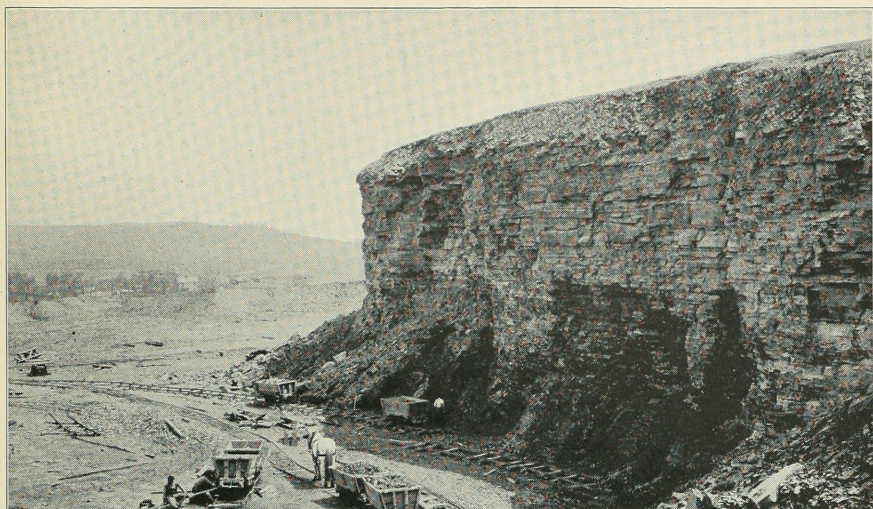
Of these cities five were in the Miami Valley, three in the Scioto, and two were lake ports.

There was a variety of factors which assisted in making Ohio in 1840 the third State in the Union. The national road, the canals, the well-developed river trade, and the lake were fundamental. The development of flour mills, distilleries, and packing houses was hardly less important. Even in 1820 there were mills in 33 of the 63 counties and there were 552 distilleries. Increased transportation facilities and opening of new markets had tremendously increased the size and number of factories. In 1831 the first threshing machine was made in the State. Previously the grain had been threshed with the flail or under the hoofs of oxen and horses. It was not until after 1850 that the black swamp region of the Maumee Valley began to be settled and at the end of the 19th century this region came into its own. Between 1870 and 1880, for example, people were migrating from Fairfield County to this new frontier. Tile draining has been the final agency by which the land was reclaimed.

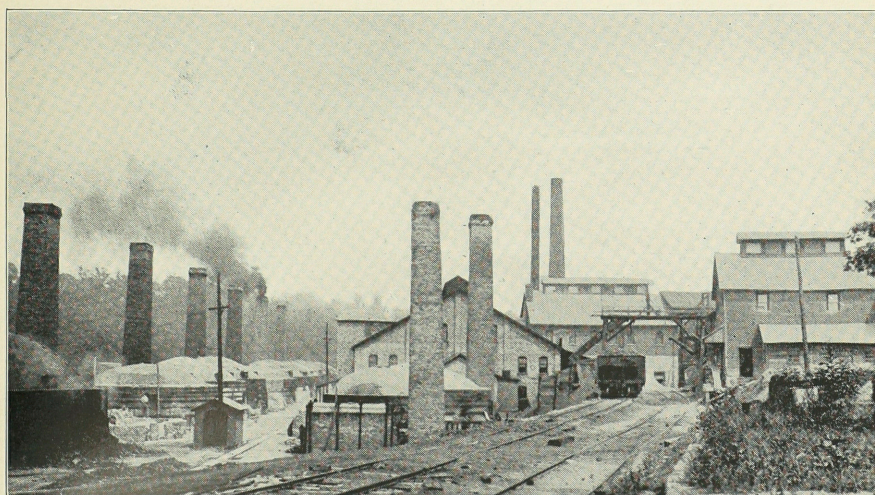
Significant in the fifties was the use of the mower and reaper. These and other implements had been invented some years before.

Corn cultivator.....	1824
Hussey mower.....	1834
McCormick reaper.....	1834
Steel plow.....	1848

Yet it was not until 1850 that they were so perfected and came into such general use as to increase the earning power of the farmer and so attract more men to the western country. There was one counter influence in this decade. Ohio lands were costly while those of the prairie states were relatively cheap; 300,000 people sold out and moved west, profiting by the exchange. There were then roughly 2,000,000 people in the State. It had taken New York 200 years to reach that



A—A shale pit in Licking County. In your imagination convert into brick all the shale removed, and you have a conception of the magnitude of the industry. (Photo by Stout)



B—Brick plant in Tuscarawas County. Near this plant are the clay and coal necessary for making brick. (Photo by Stout)

mark and Ohio but 30 years. Illinois had but 1,000,000 after 40 years of settlement. This tells eloquently the story of Ohio's richness and the importance of her position.

Statistics cannot tell the whole story of Ohio's growth. There was a quality born of the times and conditions which must not be overlooked. Ohio was a forested and isolated wilderness where man existed only by his labor. Rich and poor, aristocrat and lowly, shared the common hardships and their purifying effects. The one-crop system of the South with its attendant evils of a ruling class system and slavery had little geographic justification north of the river. The early flour producer was not a capitalist but was the miller himself. Over most of the State were broad plains, breeders of democracy. Ohio grew through the efforts of men working shoulder to shoulder, and a local pride resulted which was shared by all.

THE CHARACTER OF THE PRESENT POPULATION

Urban population has been increasing at the expense of the rural districts. A city technically consists of over 2,500. Since 1840 the rural population has increased from 1,451,367 to 2,082,258 in 1920 whereas the urban population has increased from 88,100 to 3,677,136. Moreover, some rural districts actually began to decline as early as 1850. The present density per square mile in Ohio is 117 persons and this is excelled only by six states, all of which are on the North Atlantic coast. The density of the country-side population, that is those living outside of towns (2,500) and villages (250), is 40.5 persons per square mile. This is exceeded only by New Jersey, Pennsylvania, and Maryland.

To reiterate briefly some of the causes back of the birth of the towns: The first cities were agricultural river towns, Marietta, Cincinnati, Chillicothe, Circleville, and Portsmouth. Zane's Trace left its mark on Zanesville, Lancaster, and Chillicothe. The national highway was of most importance to Zanesville, Columbus, and Springfield. The Miami Valley towns had the double influence of the rich farming country and the canal. They include Cincinnati, Hamilton, Middletown, Dayton, and Piqua. The other great canal was responsible for much of the growth of Newark, Coshocton, Massillon, Barberton, Akron, and Cleveland. The lake has played its great part in the making of Toledo, Sandusky, Lorain, Cleveland, and Ashtabula. Oil and gas developments established the prosperity of Lima, Findlay, Lancaster, and Marietta. Iron and steel have been important in most of the lake towns as well as all those of the Mahoning Valley, and Steubenville, Martins Ferry, Bellaire, and Ironton in the Ohio Valley. (Fig. 27, p. 120) If the State were divided into quarters the distribution of cities of over 10,000 would be as follows:

Northwest quarter

- 1 of 250,000 to 500,000
- 2 of 25,000 to 50,000
- 5 of 10,000 to 25,000

Northeast quarter

- 1 of more than 500,000
- 2 of 100,000 to 250,000
- 1 of 50,000 to 100,000
- 6 of 25,000 to 50,000
- 10 of 10,000 to 25,000

Southwest quarter

- 2 of 250,000 to 500,000
- 1 of 100,000 to 250,000
- 1 of 50,000 to 100,000
- 2 of 25,000 to 50,000
- 5 of 10,000 to 25,000

Southeast quarter

- 3 of 25,000 to 50,000
- 5 of 10,000 to 25,000

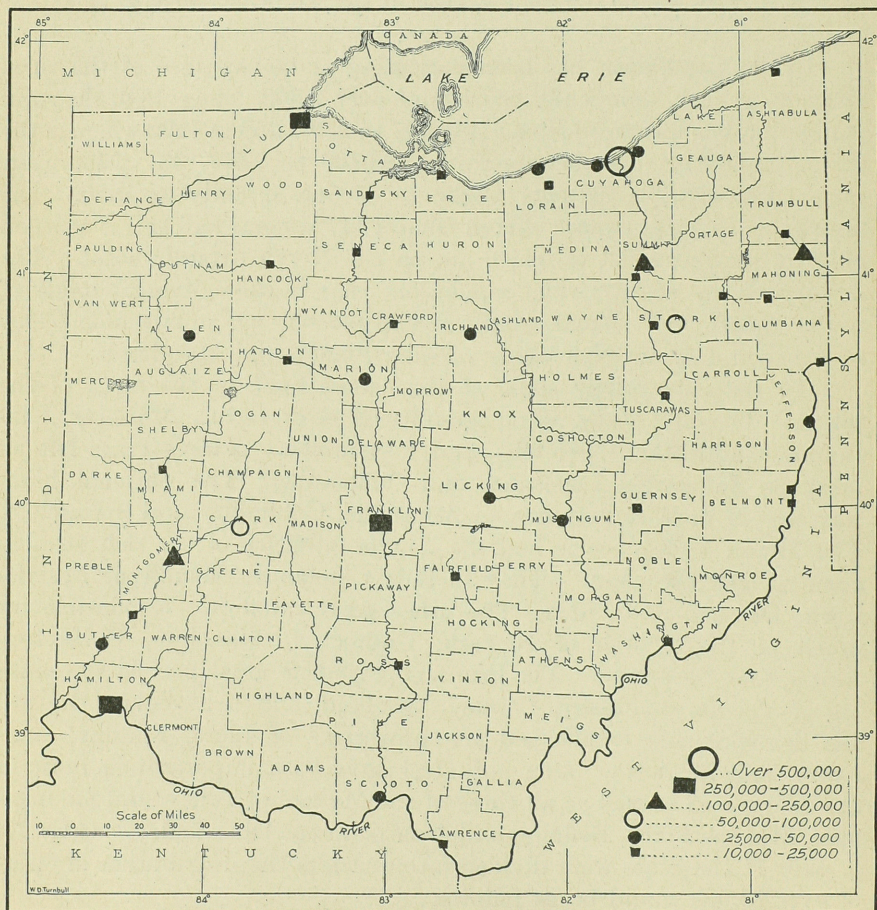


Fig. 27—Urban Centers

It is due to increase of population of these cities that Ohio owes its present vitality. Today regions of denser population are those counties in the northeast with the exception of Geauga; the coal and clay counties of Columbiana, Stark, Tuscarawas, Belmont, Perry, and Athens; the City of Columbus; Portsmouth at the mouth of the Scioto; the Lower Miami Valley; Allen County; and about Toledo. There are six counties with a rural population of more than 90 to the square mile. The acreage of farm holdings decreases as one approaches the cities and hence supports more people. Belmont and Jefferson counties besides their farm population have large numbers of miners living in small communities.

In the last decade three counties have increased their total population more than 50 per cent. This population is of a shifting industrial order and war manufacturers played a large part. The counties are Mahoning and Trumbull with their steel industries and Summit with its rubber business.

Of the 5,759,394 people in Ohio in 1920, 5,571,893 were white and 186,187 were negro. Of the negroes 155,975 lived in towns. The number of foreign born whites was 678,697 and 838,251 had foreign parentage. The foreign born are mostly in towns and are concentrated almost entirely in the iron and steel towns. Every fifth person in Cleveland is a foreigner and the Youngstown district has almost equal problems of assimilation. Also a great many of the miners in Belmont and Jefferson counties are foreign born.

THE INDUSTRIAL GROWTH

The latest stage in the growth of Ohio has been the huge industrial expansion. The principal factors affecting to a greater or lesser degree each of its industries are: (1) situation of the State in the line of east-west travel, (2) expansion of the industrial area of the Atlantic coast states until the wave of factory building reached, and then passed beyond Ohio, (3) situation between Pennsylvania coke and Lake Superior iron ore, (4) fuel resources of the State and its neighbors, (5) large and well distributed population as based on agricultural wealth. This population has furnished labor for factories as well as created a market for manufacturers.

There were in 1919, according to the Federal census, 16,125 manufacturing establishments representing 239 types of industries. These employed on the average 730,733 men earning \$944,561,734. The value of the products in that year was \$5,100,308,728 of which about 40 per cent was increased value added by manufacturing over the cost of the raw materials. Perhaps the most interesting thing from a geographic point of view in these statistics is the variety of industries. This is the outcome of the transportation facilities and also the natural complement of city growth. Where there are excellent transportation

facilities to large markets which demand a variety of goods there arises a multitude of industries which may be based to little or no extent upon local resources, as, for example, the rope industry of Xenia. The variety of products then is not wholly a measure of the variety of natural resources but of demand on the part of the peoples so easily reached by Ohio's excellent railway network. The trunk lines, crossed by many lesser railways, have developed manufacturing centers which put out a miscellany of goods demanded by our complex civilization and include such articles as rubber, art goods, toys, trunks, dental goods, and chocolate products. These are in contrast to the soap industries which are by-products of slaughtering and the preparation of food stuffs which depend largely upon Ohio's agricultural produce.

This section does not purport to give the history of industrial development. Too many economic factors must be included to explain the ups and downs of output for a bulletin which is concerned with geographic aspects. Nor will value of products in any series of years be a plain measure of the steady advance of the different industries. Therefore it is believed that the amount invested in the different industries is the best indicator of their relative importance. It must be remembered, however, that the amount invested in a brick plant is relatively small though the cost of labor is large, while a shoe factory puts a large capital into a single machine which, operated by one man, has many functions. The discrepancy due to the number of men employed is somewhat counteracted by the greater cost of skilled labor required to operate a high-priced machine. To add the cost of labor to the amount invested in factories would be unsatisfactory as, especially in late years, it has had so little stability. Keeping these conditions in mind we may consider the relative importance of the factories in terms of capital invested.

Industries in Ohio of more than \$150,000,000 invested capital in 1919

Iron and steel industries.....	\$756,043,066
Iron and steel manufacturing outside of steel mills.....	419,834,284
Rubber manufacturing.....	398,125,426
Automobiles, parts and repairs.....	262,278,128

Four industries, thus considered, are far in advance of all others in importance. They are in order: (1) the making of iron and steel, (2) iron and steel manufactured products as pipe, engines, foundry products, hardware, tools of all sorts, stoves, structural iron, and forgings, (3) rubber manufactures, principally tires, and (4) the automobile industries, including the manufacture of machines, parts and bodies, and repairing. Iron and steel making, as shown in the previous chapter, is scattered about the State; it has nevertheless a remarkable concentration in the zone terminated by Cleveland and Youngstown. This is one of the greatest iron and steel regions of the world, if not the greatest.



Fig. 28—Rural Population in 1800. Each dot represents 250 people.

Iron and steel manufacturers have a more widely scattered distribution but are naturally enough more common near the furnaces and steel mills. The lake shore and the Miami Valley are secondary areas of concentration. Among the cities which are important in this regard are Cincinnati, Cleveland, Hamilton, Dayton, Canton, Springfield, Lorain, Lima, Marion, Columbus, Newark, Elyria, and Toledo. Rubber is worked almost exclusively at Akron, where the twenty-four factories make that city the largest rubber manufacturing center in the world. The chief product is tires of which 50,000 may be made in a day. Automobiles and automobile parts and repairs have a general distribution and are found in all of the manufacturing cities. Cleveland manufactures one-half the output of the State. Toledo is second while other cities of importance in this regard are Dayton, Columbus, Springfield, Lima, Fostoria, and Elyria.

*Industries of between \$50,000,000 and \$150,000,000 invested capital
in 1919*

Electric machinery and supplies.....	\$103,340,897
Preparation of food stuffs.....	99,762,742
Clay products.....	85,948,249
Clothing of all sorts.....	76,428,610
Paper and pulp.....	74,545,550
Rail car construction.....	67,504,697
Printing, engraving, and bookbinding.....	66,808,942
Coal and coal tar products.....	54,933,952
Steel ships.....	51,177,363

In the second group, electric machinery and supplies easily lead. Dayton, Toledo, Cleveland, and Cincinnati are centers for the manufacture of lights, wire, batteries, and telephones. In the preparation of food stuffs other than milling are included canning, so important in the Scioto Valley, coffee roasting, the manufacture of flavors, and condiments, ice cream, and confectionery. The position in the table of clay products is misleading because of the small amount of investment required. The clothing industries include the making of cloth and its conversion into clothes. Though in early days it used local wools (see the chapter on agriculture) it is today a natural industry of large cities. Cleveland leads in men's clothing and Cincinnati in women's clothing. The paper industry is large because of the nearness to the Canadian woods. Rail car construction and repairs for both steam and electric roads, as well as the printing and engraving business, are normal in a region so near to the population center of the country. Coal tar products would make a greater addition to its group if this State were blessed with good coking coals. The steel ship industry, of course, is concentrated along the lake.

Industries of between \$25,000,000 and \$50,000,000 invested capital in 1919

Brass, tin, copper, and aluminum manufactures.....	\$47,997,638
Liquors and malts.....	47,005,389
Petroleum manufactures.....	46,545,550
Boots and shoes.....	40,992,143
Paints and varnishes.....	32,456,445
Slaughtering and packing.....	32,340,461
Agricultural implements.....	27,884,087
Glass.....	27,690,039
Chemicals.....	26,764,298
Furniture.....	26,334,908

Most of the industries in the third class are to be expected in so great an industrial State. Liquors and malts were here listed before the present prohibition. Petroleum manufacture is based in part upon local resources and in part upon the early establishment of industries

before the decline of the petroleum production. Boots and shoes were first manufactured from local hides. Agricultural implements were relatively more important before the depletion of hardwoods. The centers of implement manufacture have now moved west of the State. Slaughtering and meat packing are mostly done at Cincinnati but this center has been losing to cities farther west.

As industries are generally located in cities, the city growth is almost a measure of industrial development. There are today more than 90 cities in excess of 5,000 inhabitants and 9 of these have more than 50,000.

Industrial investments, number of establishments, and population of cities of more than 50,000

<i>City</i>	<i>Population (1920)</i>	<i>Amount invested (1919)</i>	<i>Number of establishments</i>
Akron.....	208,435	\$381,144,319	304
Canton.....	87,091	102,977,485	287
Cincinnati.....	401,207	268,015,132	2,239
Cleveland.....	796,841	762,585,305	2,946
Columbus.....	237,031	99,382,222	690
Dayton.....	152,559	121,658,316	571
Springfield.....	60,840	54,582,930	206
Toledo.....	243,164	206,032,674	671
Youngstown.....	132,358	186,774,621	287

The notable facts of the above table are that Cleveland stands far in the lead in amount invested and Cincinnati third though the latter city was historically the leader. Both have varied forms of manufacturing. Youngstown and Akron have comparatively few establishments but large investments. One is a great steel center and the other a great rubber center and both the home of large corporations. The other cities, with the exception of Springfield which is not large, are quite close in amounts of capital invested in manufacturing.

THE CINCINNATI DISTRICT

It is only in recent times that Cincinnati was surpassed in population by any other city and it has historically been the great city of the State. It will be worth while then to note what have been the physical factors in its growth.

Losantiville, later Cincinnati, was founded in 1788 in a depression 12 miles in circumference and bisected by the Ohio River. The river front today is 14 miles long and the city has a public dock with a frontage

of 1,000 feet. The town is central to the Ohio Valley and it is significant that it is where the river bends far northward into the Indiana-Ohio territory. Furthermore, it lies between the debouchures of the Miami and Little Miami rivers and it is just opposite the mouth of the Licking River of Kentucky.

The place grew rapidly. With the Peace of Greenville in 1794 industrial progress began. The rapid advance was due mainly to situation and it was a manufacturing town from the first because of the transportation facilities. Situated on the outer bend of the Ohio, near the wonderfully fertile Miami Valley, contributed to by the Licking, the industries which grew up in southwestern Ohio and the adjacent part of Kentucky concentrated here. Also there are few places where the Ohio Valley is wide enough for a city of size. Here there were agricultural materials for milling, distilling, and packing, wood for ship building, cooperage, and furniture making, iron ore from the Hanging Rock region, limestone in the vicinity for buildings, and clay. Coal was easily obtained by barge.

Between 1800 and 1810 the population increased thirteen fold and the city, next to Pittsburgh, was the greatest commercial and industrial center of the Middle West.

From the first Cincinnati was a commercial river town. In 1794 a regular packet line was established between that city and Pittsburgh and the Cincinnati and Hamilton turnpike was constructed in 1817. The great increase in manufactures between 1830 and 1840 was due to the Miami Canal. In 1845 this canal reached the lake. In 1840 fourteen macadamized roads connected Cincinnati with important Ohio cities and tapped the national road. It was at this period that Sir Charles Lyell referred to the city merchants as the "Pork Aristocracy," so important was the packing industry.

From 1840 to 1850 Cincinnati made the most rapid growth of any city of the Union. In order of importance her manufactures were: packing, distilling and brewing, boots and shoes, clothing, foundry and machine shop products, and furniture. Since 1850 the relative importance of the canals and river have diminished. The canal is no longer in existence and the main function of the Ohio River Valley is as a rail route. In 1851 rails were laid to Cleveland, in 1862 to Pittsburgh, in 1853 the Baltimore and Ohio Southwestern was built, and in 1857 a railroad was constructed to St. Louis. There are 10 great trunk lines serving Cincinnati at the present time. One of these, the Cincinnati Southern, was built by the city to tap the resources of the states to the south.

Today Greater Cincinnati, that is the industrial district controlled by the city, embraces 151 square miles of 5 townships of which 42 are within the city limits. In Kentucky it includes those parts of Kenton and Campbell counties about the cities of Covington and Newport,

respectively. Both of these cities have bridge connections with their larger neighbor and are essentially suburbs. Of 2,900 manufacturing establishments of the district, 2,200 are on the Ohio side. Until recently liquors and beers were the chief manufacture in value but today, soap, foundry and machine shop products, slaughtering and meat products, clothing, and printing and publishing are, in order of value, the chief manufactures.

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The early social and economic conditions of the State are excellently described in the publications of the Ohio Archaeological and Historical Society. There are many books of memoirs which are valuable. Statistical material was derived from the United States Census Bureau.

INDEX

A

	Page
Abrasives.....	82
Agriculture.....	29
early conditions.....	55, 56
Indian.....	55
present conditions.....	56
regions.....	31
statistics.....	32, 33
Alfalfa.....	41
Allegheny Plateau.....	4
Glaciated.....	4, 8, 9
Unglaciated.....	4, 6, 7
Altitudes.....	4
Apples, acreage.....	42
centers of production.....	41, 42
production.....	42

B

Barley.....	39
Bedrocks.....	9, 13
distribution.....	61
Belmont County coal field.....	67
Bibliography, agriculture.....	60
climate.....	28
mineral resources.....	86
relief and soils.....	13, 14
social and economic conditions.....	127
transportation and development of industries.....	110
Buckwheat.....	39, 40
Building stones.....	80
limestone.....	80, 81
limestone, map.....	78
sandstone.....	81, 82
uses of.....	82

C

Cambridge coal field.....	67
Canals.....	97
Canals, cities on.....	100, 101
effect on industries.....	101
effect on prices.....	101
effect on settlement.....	100
length.....	98, 99
map showing.....	94
Miami and Erie.....	98, 99
need of.....	97
Ohio.....	98, 99
routes.....	97, 98

C

	Page
Cement.....	79
natural.....	79
Portland.....	79
value.....	80
Cereals.....	34
Cincinnati district, history.....	125, 126
importance.....	126
Cities, causes.....	119
distribution.....	120, 121
in 1840.....	118
population.....	125
Clay.....	83, 84
alluvial.....	84
coal formation.....	83, 84, 85
glacial.....	84
Lower Kittanning.....	85
residual.....	84
Tionesta.....	85
uses.....	84, 85
value of products.....	83
Clay industries, history.....	107
importance.....	107
location.....	107, 108
raw materials.....	107
Clay towns, map.....	66
Climate.....	16
controls of.....	15, 16
effect of topography.....	23
Clover.....	40, 41
Coal.....	64
beds.....	64, 65
character.....	65, 67, 68
composition.....	69
extent.....	64, 65, 66, 67
fields, map.....	66
formation.....	64
Middle Kittanning.....	65
Pittsburgh.....	67
production.....	66, 67, 68
uses.....	69
Coal mining.....	68, 69
Coal towns, map.....	66
Columbus, mean annual rainfall.....	23
mean annual temperature.....	23
precipitation chart.....	22
Corn, acreage.....	34, 35
center of production.....	31
history.....	34
production.....	34, 36
Crops, table showing.....	32, 33, 34
pioneer.....	56
weather influence.....	24

C

	Page
Cultivated areas.....	29
percentage.....	31

D

Dairying.....	45
changes.....	48, 49
products.....	48, 49
receipts.....	49
receipts, map.....	49
Droughts.....	27

F

Farmers, nationality.....	57
Farms, acreage.....	57
fruit trees.....	43
improved lands.....	31
in southeast Ohio.....	54, 58
number.....	29, 30, 57
value.....	29, 30, 53, 54, 55, 57
Federal Creek coal field.....	67
Findlay, map.....	115
Floods.....	24
causes.....	25
in Ohio Valley.....	24, 25
March, 1913.....	26, 27
Frosts.....	17, 18
maps.....	18, 19
Fruits.....	41, 42, 43
table showing.....	43

G

Gas.....	73
at Cleveland.....	74
at Findlay.....	74
at Lancaster.....	74
consumption.....	75
fields.....	73, 74
history.....	70, 73, 74
map.....	72
occurrence.....	70
production.....	74, 75
rocks producing.....	70, 75
Geologic column.....	62
Geology.....	9
Glacial Plains.....	3, 4, 5
agriculture.....	50
rural conditions.....	54, 59
topography.....	4

G

	Page
Glaciated Plateau.....	4, 8, 9
agriculture.....	50, 51
farm values.....	52, 54, 55
live stock.....	52
productivity.....	51
Glaciation.....	10
effect on agriculture.....	50, 51, 52
effect on soils.....	50
effect on topography.....	50
Government grants.....	114
Grapes.....	43
Gravel.....	82
Great Lakes, boats.....	104
freight rates.....	104
influence on iron manufacture.....	103
ore traffic.....	103
ports.....	104
Growing season.....	18
Growing season, map.....	20
Gypsum.....	77
Gypsum, map.....	78

H

Hay and forage, acreage.....	34, 40
production.....	40
Hill country.....	6
farms.....	58, 59
Hocking Valley coal field.....	65

I

Indians, living conditions.....	112, 113
locations.....	112, 113
tribes.....	112
Industries, history.....	87, 88, 89
localization.....	123
types.....	68, 69, 107, 108, 121, 122, 124
value of.....	121, 122, 124, 125
Industry, factors in growth.....	121
Iron manufacture, history.....	102
importance.....	104
ore for.....	102, 103, 104
regions.....	103, 104
Iron ore.....	69, 70, 102, 103, 104

L

Lakes (see also Great Lakes).....	12, 102
Lake Plains.....	3, 4, 6

L

	Page
Lime, areas.....	80
burning.....	80
production.....	80
uses.....	80
value.....	80
Limestone, building.....	80
Devonian.....	78, 81
industrial.....	77, 78
map.....	78
markets.....	79
Mississippian.....	78, 81
Ordovician.....	77, 80, 81
Pennsylvanian.....	78, 81
Silurian.....	77, 81
uses.....	79
value.....	77, 79

M

Manufacturers, history.....	88, 89
iron and steel.....	102, 103, 104
number.....	121
value.....	121, 122
Maple trees.....	45
Marietta, map.....	117
Minerals, kinds.....	61
value.....	61
Mineral waters.....	86

N

Negroes.....	57, 58, 121
--------------	-------------

O

Oats, acreage.....	34
map.....	39
production.....	38
Oil.....	70
character.....	71
fields.....	71
history.....	70, 71
influence.....	73
map.....	72
occurrence.....	70
production.....	71, 73
rocks producing.....	70, 71, 73
well records.....	71, 72

P

Pasture province.....	31
Peaches.....	42

P

	Page
Peat.....	63
area.....	64
formation.....	63, 64
topographic conditions.....	64
use.....	64
Physical history.....	9
Physiographic provinces.....	3, 4
map.....	3
Plains, farm values.....	54, 55
glacial.....	3, 4, 5
lake.....	3, 4, 5
lake, map.....	6
rural conditions.....	59, 60
till, map.....	5
Plateaus, farm values.....	54, 55
glaciated.....	4, 8
glaciated, map.....	9
rural conditions.....	58, 59
social conditions.....	58, 59
unglaciated.....	4, 6, 7
unglaciated, map.....	7
Population.....	1, 116
causes of growth.....	118, 119
character.....	121
density.....	119, 121
early centers.....	116
employment.....	117
growth.....	116, 121
rural.....	117, 119, 123
urban.....	117, 119, 125
Potatoes, acreage.....	34
center of production.....	43, 44
Precipitation.....	19, 20, 21, 25, 26
at Columbus.....	22, 23
in Ohio River Basin.....	26
mean annual.....	21, 22

R

Railways.....	105
effect.....	106
electric.....	108, 109
history.....	105, 106
mileage.....	105
systems.....	106, 107, 108
Rainfall (see also precipitation).....	19, 20
at Columbus.....	23
influence on crops.....	24
Relief.....	3, 4
Rivers.....	5, 6, 7, 8
River traffic.....	89, 90, 91
towns affected.....	91

R

	Page
Roads, early conditions.....	92, 93
in 1807.....	92, 93
importance.....	109
National Highway.....	92, 94, 95, 96
Zane's Trace.....	92, 93, 94
Rural conditions.....	57
churches.....	58, 59, 109
farm acreage.....	57
farm population.....	57, 117, 119, 123
farm values.....	57
labor costs.....	59
living conditions.....	58
schools.....	59, 109, 110
social conditions.....	58, 59, 109

S

Salt.....	75
at Pomeroy.....	76
effect of canals on.....	101
extent of field.....	76, 77
history.....	75
in northeast Ohio.....	76
manufacture.....	75, 76
map.....	72
production.....	76, 77
Sand.....	82
location.....	83
uses.....	83
value.....	82
Sandstone.....	81, 82
Berea.....	81, 82
production.....	82
value.....	82
Settlements.....	113, 114, 115
Shale.....	83, 84
uses.....	84
Shipbuilding.....	89
early boats.....	90, 91
lake boats.....	103, 104
Situation.....	1
importance.....	111, 112
Size.....	1, 22
Snowfall.....	21
at Columbus.....	21, 23
Soils.....	11, 12
glacial.....	13, 50
map.....	11
residual.....	12, 13
transported.....	12, 13
Steel industry (see iron).	

S

	Page
Stock raising.....	45
cattle.....	46, 47, 48, 56
cattle, map.....	47
sheep.....	45, 46
swine.....	46
table showing live stock.....	52
Sugar beets.....	44
Swan Creek coal field.....	67

T

Taverns, early.....	94, 96
Temperature.....	16
frosts.....	17, 18
influence on crops.....	24
mean annual.....	15, 16
mean annual at Columbus.....	23
range.....	16, 17
variations at Columbus.....	23
Tobacco, acreage.....	34, 44
production.....	44
Topography, affected by glaciation.....	50
influence on climate.....	23
Transportation.....	87
canals.....	97
effect on farm values.....	54, 59
effect on industry.....	87, 108
lakes.....	102, 103
obstacles.....	87
railway.....	105, 106, 107
recent aspects.....	108
river.....	89, 90, 91

U

Unglaciaded Plateau.....	4, 6, 7
bedrocks.....	13
effect of glacier.....	50
farms.....	51
farm values.....	52, 54, 55
live stock.....	52
productivity.....	51
soils.....	13

V

Valleys.....	5, 6, 7, 8
Valleys, preglacial.....	11
Vegetation, natural.....	27, 28

W

	Page
Weather, influence on crops.....	24
Wheat.....	36
acreage, map.....	37
acreage, table.....	34
center of production.....	31, 36, 37
first crop.....	56
production.....	36, 38
Winds.....	16, 21
cyclonic storms.....	21, 22, 24
velocity at Columbus.....	23

